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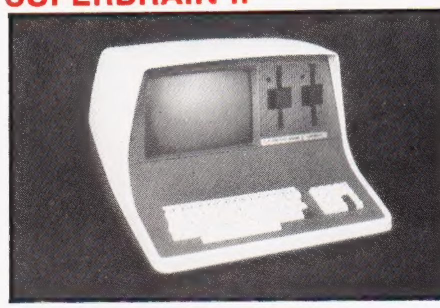

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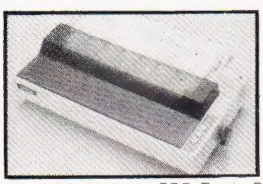

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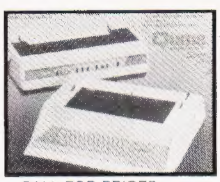

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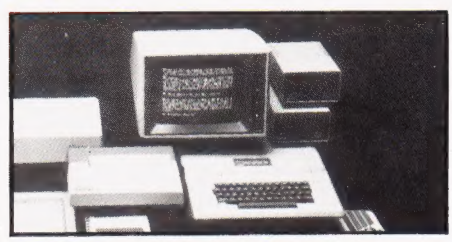

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All work for consideration should be sent to the Editor at our Charing Cross Road address.

CONTENTS

VOL 4 No 9 NOVEMBER 1982

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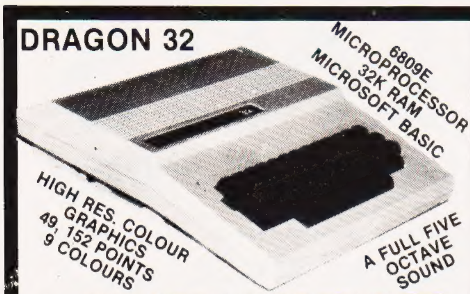
DRAGON 32



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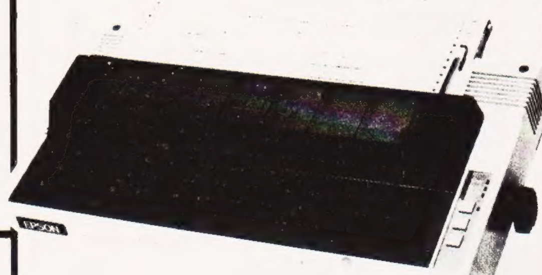

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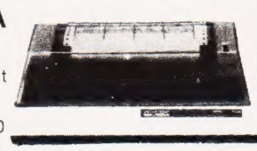

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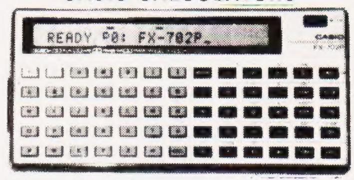

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QUICKPROPLUS

Quickpro Plus is a Basic program generator. That is to say you tell it the type of program you want and it writes it for you. The most widely publicised of such program generators is The Last One and it is, therefore, inevitable that Quickpro Plus will be compared with it.

There are two approaches that one can take in writing software like this. Either one can set out with a very broad brush and try and make the generator capable of producing a wide variety of data handling software or one can restrict it to some extent, to simply producing file handling programs. The Last One seeks to go the first route, Quickpro Plus goes the second. There is a great paradox in this software if one thinks about it. Obviously, if a person is at least a semi-skilled programmer then he does not need a program generator. They are really for people who are not skilled in programming and want that chore taken off their hands The paradox is that programs like The Last One, by being all things to all men are also complex in use and one therefore gets the position of a program aimed at a beginner, but actually requiring some skill to use it.

It was because of this apparent paradox that Quickpro Plus came into being. It is written for somebody with little or no knowledge. You will find no mention of flow-charts and little mention of fields, records and other technicalities. It was written so that a person could sit down in front of his computer, answer a few questions and have a program produced for him, and this is exactly what Quickpro Plus does. The other side of the coin is that it concentrates entirely on producing file handling programs. Within that context the program which you have generated will run on the computer like any other Basic program. You will be able to add file records, in other words items of information in your file. You will be able to search for and locate records, and retrieve these records, as and when you wish; you will be able to up-date and change the records, indeed you can delete them altogether. In the program generation process you will be able to design your own screen layout. Co-ordinates appear on the screen and you simply say where you want questions and statements to be inserted. You will, of course, be able to define whatever part of the record you will wish to use as a search key. These fields may be restricted if you wish to just numeric data and, of course, you may name the data file and indeed the program as you desire.

An added feature is that you may carry out various calculations on any of the numeric fields and if you want to you can change this numeric data. Up to fifty separate computations can be carried out on these fields. The program will report the calculations to you in various arrangements using any of the normal mathematical functions.

Quickpro Plus supports a full print report facility. Indeed within minutes you can design a new report with any column names that you choose, with any calculations that you might want and for many selections of records in your total file. A report will be produced within seconds. This can have been built into the program or you can re-arrange matters so that you get a one time reporting. The same file is thereby manipulated in many different ways. Computations are done and results printed all from the same file which your program has produced.

Quickpro Plus is available for the Model I, Model II and Model III Tandy machines, together with the original Video Genie, the Genie I and Genie II. A version for the Genie III will be available towards the end of 1982. Quickpro Plus is, of course, disk orientated and has no application for cassette users. It is supplied on a protected disk, but Molimerx have masters from which they can repair any damaged disks and hence retain their reputation for support.

The Last One is a Registered Trademark of D.J. A1 SYSTEM LTD.

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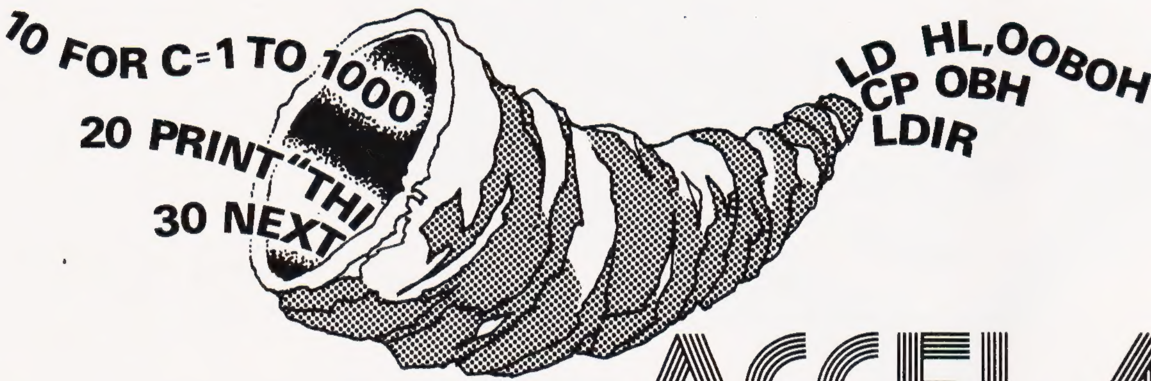

ACCEL 4

Another ACCEL to continue the evolutionary trend of these unique basic compilers! The first ACCEL a tape orientated compiler, was first introduced by Chris Paradine at the end of 1979. Since then it has gone through a number of enhancements, chiefly in speed and the number of basic statements which it will compile.

ACCEL 4 continues this trend, but its principle feature is its ability to leave memory untouched, except for about 127 bytes, at run time. In other words essentially all user memory is available for the compiled program. So far as is known this is the first time that such a claim can be made for a basic compiler available for the Tandy and Genie machines. It is indeed, therefore, "A Horn of Plenty".

Furthermore by reason of some very clever programming, ACCEL 4 approaches the other ultimate aim of a compiler, namely that the compiled program should be the same or less length as the original. It is inherent in compilers that the Object code is longer in length than the Source code. It is difficult to see how this cannot be so, but in one or two programs ACCEL 4 even achieves this aim.

It is impossible to give performance figures for a compiler in respect to speed of execution. This would vary with some programs to a quite startling factor of may be 20 or 30 times faster than the original and at the other end of the spectrum some software is not worth compiling. The criterion is, of course, the amount of time the program spends in accessing the peripherals. No compiler can change the length of time it takes a printer to print, nor the time a disk drive takes to read or write. In the worst case with a program whose sole object is to read or write to disk, and assuming that this is being done by the program continuously in its uncompiled form, then little or no speed increase will be achieved. A program, however, that spends its time doing calculations, manipulating strings or other work that is a function of the CPU, will benefit greatly.

Like its forefathers, ACCEL 4 supports Microsoft Basic and compared to its antecedents has very few restrictions. When ACCEL meets a Basic statement that it does not wish to compile or is unable to compile, it merely leaves it as it is and when such a statement is met at run time, ACCEL passes control back to the machine's interpreter for that line. One finishes up therefore with a rather unique combination of machine code with a sprinkling of Basic. ACCEL 4, however, supports pretty well all of the important Basic statements and commands.

ACCEL 4 is compatible with TRSDOS, LDOS and smal-LDOS on Model I and Model III Tandy machines, together with the original Video Genie, the Genie I and Genie II.

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CONSUMER NEWS

FORTHCOMING . . . ▲

So what's new about the Jupiter Ace? Well, for one thing it uses FORTH as its main language.

Priced at £89.95, the Jupiter Ace package consists of the machine itself, a mains adaptor, all the necessary leads and a software catalogue and manual. The manual provides a complete introduction to the FORTH language so beginners take heart.

The Jupiter Ace is based on the Z80A processor and has 3K RAM. A 40 moving-key keyboard is built into the unit and output is via a normal UHF TV giving a memory mapped, 32 x 24 character display with Hi-Res graphics.

At present, the Jupiter Ace is on sale by mail order only but for further information get in touch with Jupiter Cantab Ltd, 22 Foxhollow, Bar Hill, Cambridge CB3 8EP or telephone them on 0954-80437. And, if you're comparing it to the ZX Spectrum, you may be interested to know that the Jupiter Ace was designed by Richard Altwasser and Steven Vickers — two important names in the evolution of the Spectrum.

THE CASE FOR SINCLAIR

Here's a range of products for the ZX81 owner who has everything!

Called Jigsaw, the new range comprises an attache case which will have a number of separate compartments. Into the individual areas will go a RAM pack (16K, 32K or 64K), a keyboard, a floppy disc, a printer, a flat screen, an audio link, a cassette player, a modem, a rechargeable battery and, of course, the ZX81 itself. There is also a series of illuminated indicators set inside the case to warn the user if any of the units have not been connected correctly inside their compartments.

Any individual item or combination of items can be purchased separately or you can buy the whole package for under £1,000. For further information write to Computer Aided Printing Services, 28 The Spain, Petersfield, Hampshire GU32 3LA or 'phone 0730-67221.

THE FINAL FRONTIER ▼

No, Laskys haven't set up shop on the moon — yet! But, according to them, they have taken "the next big step forward . . .". Laskys and Hewlett-Packard have joined forces to provide the complete HP package in the High Street.

In a new leaflet they have produced, you'll not only find details of the HP-87 and HP-85 Personal Computers, the HP-7470 Sweetlips plotter and the HP-9134 Winchester disc but there's also a voucher included offering free accessories to the value of 10% of the purchase price of the computer. Of course, this voucher can only be used when you part with your money in a Laskys store, but it's worth bearing in mind.

So, next time you're strolling down the High Street, check out the HP range. For details of where you can find your nearest Laskys store, get in touch with Laskys, Hardman House, The Hyde, London NW9 6JJ or 'phone them on 01-200 0444.

RIGID FLOPPIES?

Developed from a range of microfilm reference aids and strip index systems, a new series of data storage units are being produced by Kardex.

The first of the series to become available is a wallet for organising and protecting floppy discs. Tailor-designed to suit either 8" or 5¼" discs, each wallet has 20 transparent pockets which fan out as the unit is opened. The format of the pockets maintains the correct separation between adjacent discs for full data integrity.

The 8" and 5¼" version of the wallet are priced at £17.75 and £13.65 respectively. For further information on the wallets and the rest of their range, get in touch with Kardex (UK) Ltd, 2 Dyers Buildings, Holborn, London EC1N 2JT or telephone 01-405 3434.

A GRAND MACHINE? ►

The 64K CP/M computer from Lowe Electronics will actually cost a little less than a grand — a mere £999 + VAT.

Complete with 64K RAM and 13.5K ROM, the CP/Genie is supplied with a 12" monitor and operates under CP/M 2.2 which is provided with every machine. The CP/Genie also boasts a 64 by 16 screen format and is fully compatible with existing Genie 1 software including Genie DOS (Smal-LDOS) which is also included as part of the package.

The CP/Genie incorporates a single disc drive but there is a second version of the machine available with a dual disc drive priced at £1,175 + VAT. For full details on both versions of the GP/Genie contact Lowe Electronics Ltd, Chesterfield Road, Matlock, Derbyshire DE4 5LE or 'phone them on 0629-2430.

You may also be interested to know about the Brother HR1 which Lowe are distributing for around £600 + VAT. The Brother HR1 is a Japanese daisy wheel printer with a print speed of 16 cps and incorporates bi-directional friction platen paper feed as standard.

THINK BIG ▲

In this age of miniaturisation, here is a product, the TT100 Video Terminal, which is notably bigger than most of its compatible products in the field.

Complete with a 15" green or amber screen, the TT100 package also includes a printer port, advanced video, multiple character sets and a detachable sculptured keyboard. The TT100 incorporates VT100 Emulation allowing it to be utilised on all DEC-based systems.

Priced at £950, you can find out more about the TT100 Video Terminal from Rockhall Ltd, 1 Park Rise, Leicester LE3 6SG. Telephone enquiries can be made on 0533-874097.

IT ALL ADDS UP

Texas Instruments have introduced the TI Peripheral Expansion System which allows you to add up to seven peripherals in a single unit to the TI-99/4A home computer.

The system will house a 5¼" floppy disc drive as well as a number of other cards such as an extra 32K of RAM plus parallel and RS232 interfaces. That should certainly take care of that tangled web of cables usually associated with the addition of peripherals!

For further details of the TI Peripheral Expansion System and the rest of their range of add-ons for the TI-99/4A, contact Texas Instruments Ltd, Manton Lane, Bedford MK41 7PA. Telephone enquiries can be made on 0234-67466.

MADE IN JAPAN ▼

Direct from mainframe manufacturer, Fujitsu, comes the Micro 8 Personal Computer which contains not one, not two, but three processors.

The main processors of the machine are twin 6809s which handle the 640 by 200, eight colour Hi-Res graphics and the third processor, a Z80A, allows for the use of CP/M based software. The Micro 8 also features a real time clock, parallel and serial interfaces, and 32K of Microsoft F-BASIC contained in 128K of total memory.

The Micro 8 incorporates a software controlled screen format (between 40 and 80 columns) which can be programmed into any of the 10 programmable function keys. Software available for the machine as it stands includes CP/M, FORTRAN, COBOL, Pascal, FLEX and MICROPRO. There is also the option for bubble memory and 5¼" and 8" double-sided double-density discs.

The Micro 8 Personal Computer is priced at £895 + VAT and is available from Minichip Ltd, Enterprise House, Terrace Road, Walton, Surrey. For more details you could always ring them on 09322-42777.

ATOM & BBC

"ZODIAC"

Following the success of our 1st Adventure Competition (winner to be published next month). We are launching our second Adventure Competition (we have doubled the prize money as well). "Zodiac" is your greatest challenge yet from A&F. Solve the problem of this Astrological Adventure and you could win £100.

Full machine code program requires 12K RAM.

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Closing date 30/11/82 the winner will have £100 in his hand in time for Christmas.

NEW ATOM

TORPEDO RUN
Another fantastic high resolution (clear 4) real time game for the "Atom". Can you complete your mission and destroy the enemy convoy? Will you return to a heroes welcome or is Davy Jones Locker your final resting place!!!
5K Text 6K Graphics **Price £4.95**

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NEW

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As you sit in your starfighter looking out into the void of space remember the CYLON race only want Mankind for food!! You glance up at your long range scanner, the CYLON fleet is in range. Quickly you select a target and turn to meet it ready to defend Earth to the end!!
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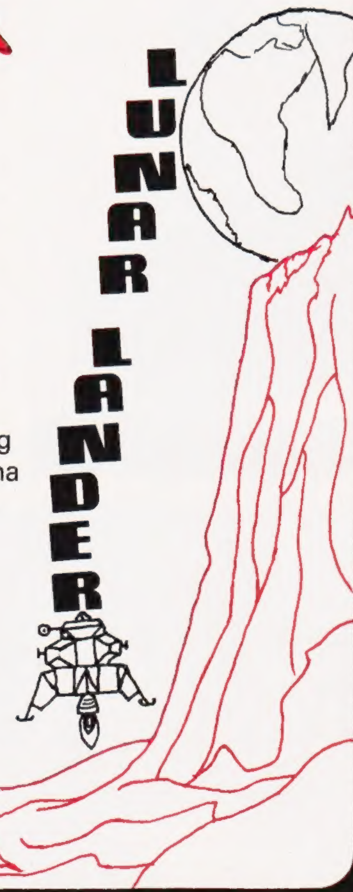

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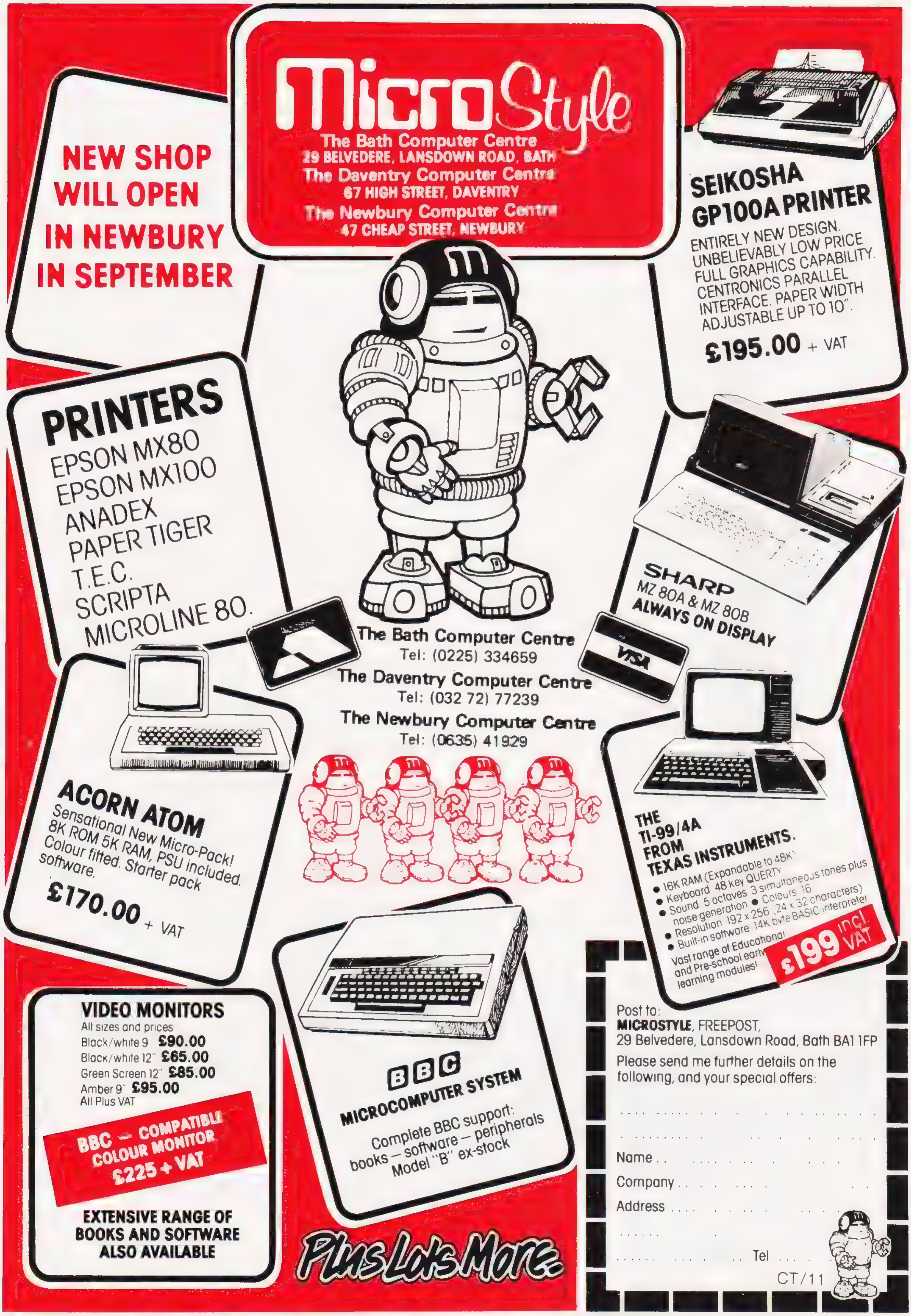
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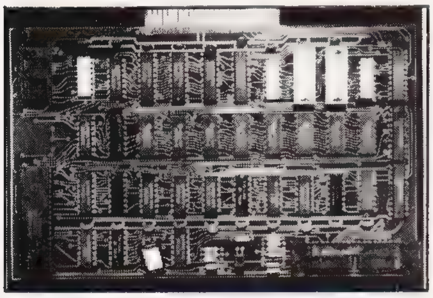
BUSINESS NEWS

A NEW DEAL FROM ACT

If you are an ACT Sirius 1 owner you may, at sometime, have wished you could run standard eight-bit CP/M and other applications software. Well, now you can.

To make this conversion, you will need the Sirius-80 card from Small Systems Engineering. Based on the Z80 processor, the Sirius-80 card offers an additional 64K RAM as well as a hard disc interface allowing direct connection to the Corvus range of hard discs.

The Sirius-80 card will retail at £299 + VAT for the 4 MHz version and £335 + VAT for the 6 MHz version. For further information get in touch with Small Systems Engineering, 2/4 Canfield Place, London NW6 3BT or 'phone 01-328 7145.



A MARKETING MICRO

Developed especially for the Marketing, Advertising and Communications industry comes the GC 1000 which can be used in a variety of applications.

Based on the 709E/AT & T North American Viewdata Standard, the GC 1000 has 128K of core memory and incorporates twin 5¼" double-sided double-density disc drives. The machine also includes a built-in real time and date clock, and an operating system giving access to high level languages such as Pascal, BASIC 09, C and assembler language if required.

The device offers the facility to create a wide range of graphics and illustrations using an electronic graphics drawing tablet (available as an optional extra) or the keyboard. There is a choice of using 35,000 different colours although only 16 can be displayed on the screen simultaneously.

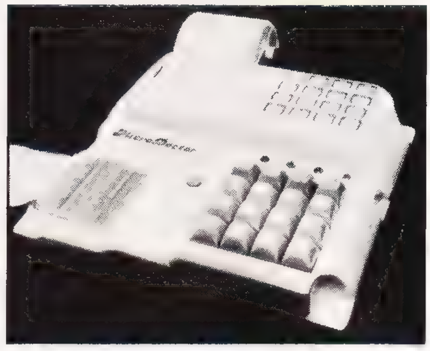
The GC 1000 can also be used as a dedicated word processor, and an optional daisy wheel printer is available which can be connected to one of the communication ports.

Retailing at £8,750, further information can be obtained from Poulter Compuvision Systems, Poulter House, 2 Burley Road, Leeds LS3 1NJ. If you want to telephone them try 0532-469611.

ON PRESCRIPTION

The Microdoctor is a device designed to help engineers track down those annoying faults in computers and other microprocessor-controlled machines.

Locating the MD's probe in the MPU socket, the device diagnoses the various faults from the point of view of the microprocessor. First, a memory map can be printed to find ROM, RAM and I/O, and then a dump in Hex or ASCII will locate the data tables. Once this has been done, a search will find the software routines which can then be disassembled. All the engineer has to decide is in what order the tests should be made and which of the 15 test sequences, each containing up to 12 tests, are required. The MD issues a printed report of the tests and results for future consultation.



The MD is based on the Z80 processor and incorporates 4K of firmware and 1K of CMOS RAM with Ni-Cad backup. Two configuration cards are supplied with the device, one for the Z80 and one uncommitted for use with different computers. A 20-column thermal printer is built into the package which comes complete for £295 + VAT.

So, if you want to take all the fun out of 'Doctors and Nurses', maybe what you need is the Microdoctor. For further details contact Dataman Designs, Lombard House, Cornwall Road, Dorchester, Dorset DT1 1RX or 'phone 0305-68066.

A NEW TYPE?

As a replacement for the now defunct 8026 and 8027 printers, Dataplus have introduced the Scripta II, an 'on-line' terminal/'off-line' typewriter which has an integral interface for all Commodore computers.

The Scripta II accommodates paper of up to 17" wide with a 14" printing line and can print 10, 12 and 15 characters per inch plus proportional spacing. The microprocessor controller is logic seeking providing bi-directional printing and this, combined with a 4K buffer, allows the device to print a document while the user organises the next task on the computer. The Scripta II can also be supplied with an RS232 or Centronics interface if required.

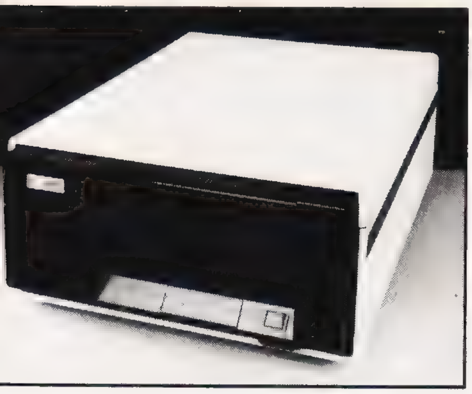
Optional extras for the Scripta II include paper-handling devices to feed simple sheets, envelopes, listing paper and invoices, etc. There is also a wide variety of 96 character daisy wheels available in different fonts and languages.

Retailing at £1,098, further details are obtainable from Dataplus, Ltd, 39-49 Roman Road, Cheltenham, Gloucester GL51 8QQ or telephone 0242-37373.

DRIVING THE SUPERBRAIN

The KODE ½" nine track 1600 bps phase encoded format type drives are now available for use with the SuperBrain.

Allowing easier transfer of data between mainframes and the SuperBrain, the unit also provides backup facilities for the Winchester drives which are widely used with the SuperBrain. Also available as part of the package is a tape interchange program which enables simple file transfer between disc and tape at speeds of up to 40,000 bps and is similar in nature to CP/M's PIP command.

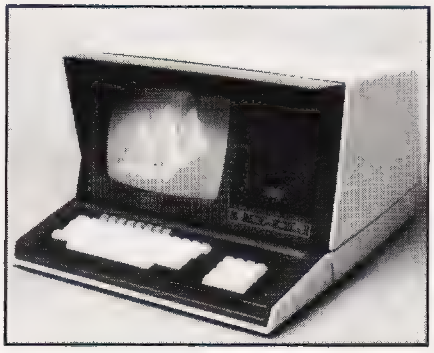


Interfacing to the SuperBrain is carried out via the S100 adaptor and complete testing and fitting is carried out by Cambridge Micro Computers Ltd for £4,450. For more details on the device contact Cambridge Micro Computers Ltd, Cambridge Science Park, Milton Road, Cambridge CB4 4BN. Telephone enquiries can be made on 0223-314666.

A WIZARD MACHINE

Who says the magic has gone from microcomputing?

The Merlin is a Z80 based micro with a detachable 76 key keyboard with five programmable function keys and a 15 key



numeric keypad, and a matt green screen with a 64 by 16 display. There are also two disc drives built into the package offering from 200K to 1.5M.

The machine itself has 48K RAM and an internal 48K ROM containing Microsoft BASIC. Each machine is supplied with LDOS, Tandy's TRS DOS, and is capable of running all TRS-80/Genie software packages. There is also a Centronics interface.

Complete with manuals and a software source listing, the Merlin is priced from around £1,500. For further information contact CT Maddison Ltd, Eagle Industrial Estate, The Crofts, Whitney, Oxford OX8 7AZ or 'phone 0993-73145.

And while you're talking to them you could also mention the various add-ons that CT Maddison are furiously working on. These include an RS232 interface, a dot addressable Hi-Res graphics board, a hard disc storage option and a CP/M 2.2 operating system.

TOP OR THE POPS

A S100 based British microcomputer, the Minstrel, has been announced which is North Star Horizon compatible.

The basic Minstrel incorporates a single card comprising a Z80A processor, 64K RAM and serial and parallel ports, a 5¼" floppy disc drive of 400K or 800K, and a 5¼" Winchester drive of 5-20M capacity; the Winchester drive system should be available with 60M by the end of the year.

The system also offers a number of options including slave Z80 processor cards and 16-bit processor cards. There is a choice of three operating systems available on the Minstrel: CP/M, MINOS (North Star DOS compatible multi-user operating system) and OASIS.

The price of the 5M Minstrel and the 20M version are around £2,550 and £3,200 respectively. For further information contact Hotel Microsystems Ltd, 69 Loudoun Road, London NW8 0DQ. Telephone enquiries can be made on 01-328 8737.

EXTRA, EXTRA ▼

A 6M Winchester disc option, designed and assembled by IBR, is now available for the PC-8000 microcomputer.

Providing the PC-8000 user with around 5M of formatted data storage with an average access time of 70 mS, the Winchester disc is priced at £1,995 and delivery times are claimed to be in the order of three weeks.

Virtually all the software currently available for the PC-8000, including modules running under CP/M, will be usable on machines fitted with the disc option. The device, designated HD8000-6, can also be backed up by flexible disc if required.

For further details of the HD8000-6 contact NEC Telecommunications Europe Co Ltd, NEC House, 164-166 Drummond Street, London NW1 3HP or telephone them on 01-388 6100.

You might also like to ask them about two software packages — an integrated accounts system and a records management package — both of which will operate with either the flexible disc or the Winchester disc option.

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Please ask your DE dealer for details of the latest Anadex models.

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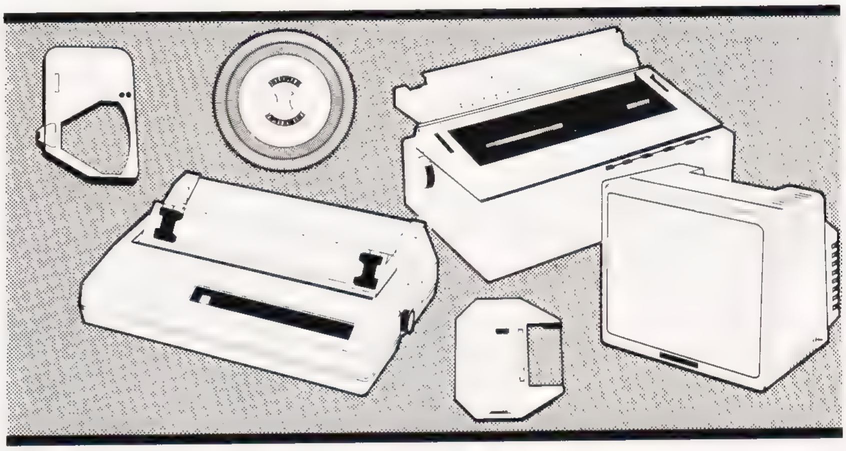

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SOFT WARES

ACTING ON INFORMATION ▲

An information package called Sirius DATAFLOW is now available for use on the ACT Sirius 1.

Designed to take full advantage of the Sirius 1's features, DATAFLOW can handle any filing or data retrieval task involving 150 to 1,500 records. The package is claimed to be user friendly and Raven Computers further boast that first time users could set up a database, enter sample data and produce reports and labels to exact requirements within 30 minutes. Applications for this package include those involving stock/price lists, job costings, mailing lists, personnel records, invoice registers, sales analyses, etc.

Retailing at £125, further information on the Sirius DATAFLOW can be obtained from Raven Computers, 153 Sunbridge Road, Bradford BD1 2NU. Telephone enquiries can be made on 0274-306966.

DATAFLOW is also available on a number of other CP/M based microcomputers and for details of these versions contact Great Northern Computer Services Ltd, 16 Town Street, Horsforth, Leeds LS18 4RJ or 'phone 0532-589980.

A SOFT TOUCH

Stainless Software have released a catalogue of their latest games software for the TI-99/4A.

Among the programs available are Tickworld, a game of capture and escape; Winging It, a flight simulator; Maze of Ariel, an adventure set in a labyrinth; Starship Pegasus, a space game; Hordes, a game of global conquest; and Ant Wars, an insect world combat simulation. And there's a lot more where that came from!

All the software is priced between £6-10 and is available from Stainless Software, 10 Alstone Road, Stockport, Cheshire SK4 5AH.

THE BOSS ▼

Audiogenic Ltd have been very busy of late providing software for the VIC-20.

First up is the Boss, a chess game available as a cassette for £14.99. It gives 10 levels of play providing response times from one second to nine hours. The program is also capable of castling, queening and 'en passant' as well as a wide range of opening moves.

Also announced are five cartridge games which plug directly into the back of the VIC and feature autoload, taking the user straight into the game. The titles are Spiders from Mars, Cloudburst, Renaissance, Satellites and Meteors, and Meteor Run. All are priced at £24.99 except for Cloudburst which retails at £19.99.

For further information on these games get in touch with Audiogenic Ltd, PO Box 88, Reading, Berks or 'phone 0734-595647. You might also like to ask them about Wordcraft 20, a comprehensive word processing package which, when linked to a printer, should transform your VIC into a word processing system. The Wordcraft 20 package is priced at £125.

MISSION IMPOSSIBLE ▲

Well, Choplifter, an arcade style game for the Apple II or Apple II Plus with 48K and DOS 3.2 or 3.3, may not be impossible, but it sounds pretty difficult!

There you are, a helicopter pilot based on a US Command Post with four barracks, each containing 16 hostages. One of the barracks has just been blown up and the hostages are running scared in enemy territory. All you have to do is to rescue all 64 hostages in your helicopter — which unfortunately only seats 16.

Sounds easy? Oh, did I forget to mention the enemy jet fighters with their air-to-air missiles, the tanks and the drone air mines which home in on your helicopter?

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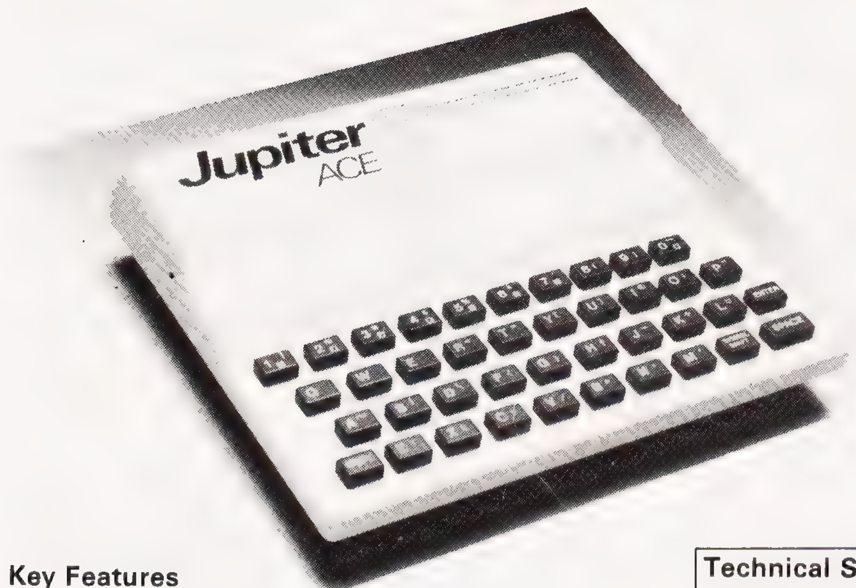

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THE SOUND OF MUSIC

Our musical theme continues next month when we take a look at the facilities offered by the BBC Micro's SOUND command. In this, the second of our occasional series on the BBC Micro, we'll be investigating the power of this deceptively simple command and showing the range of complex sounds which it can produce.

We'll also be concluding our Micro Music feature with a practical demonstration of just what can be achieved using the currently available hardware and software. It may not actually replace your friendly local composer but it's certainly a whole lot quicker.

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VISION ON

Producing an object on your screen in 3-D is not too difficult. Making an object rotate is slightly harder. Doing both at once may seem almost impossible on one of today's micros. Fear not. Next month we reveal an extremely clever and simple way of making a 3-D object move on your screen. It's all done in BASIC and it's so simple you'll probably kick yourself for not thinking of it on your own!

THE SERIOUS ONE

Well, so the apocryphal story goes. Yes, the Sirius system was, if you can believe it, so named by its designer to inspire confidence with the business market. Regardless of whether the story is true, it has certainly proved to be a very popular system for the professional and business markets. Next month we take a look at this 16-bit machine and assess its impact on the market in the absence of IBM's baby. For the full story of what makes a Sirius tick, don't miss the December issue.

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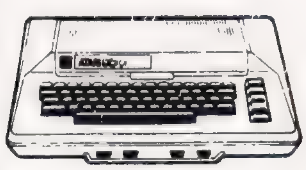

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ENTER THE DRAGON

British designed and built, this 6809-based system could represent the first 'off-the-peg' home computer. We venture inside for a close look.

Over the last 18 months, the computer market has seen a considerable number of microcomputer systems which all seem to offer the same basic specification. In general, these are based around the well-proven Z80 processor and feature the maximum allowance of RAM (64K) together with twin discs, the CP/M Disc Operating System and a variety of software packages and language options.

The main reason for this proliferation has been that it is, in general, cheaper to fully equip a system of this type than to offer memory expansion and hardware add-ons as extras. Memory and disc drive prices have fallen as a result of the increased demand and this can be passed on to the bulk buyers allowing them to build comprehensive systems at the same price as the basic unit would have cost some 12 months ago.

Now, the main reason for the similarity is that there are only a finite number of ways in which you can assemble a certain family of chips: CPU, RAM, I/O and peripheral devices. It took about two years before the manufacturers started to capitalise on this and reduce their design costs significantly. It is therefore, interesting to note that one new manufacturer has followed the example of his predecessors and produced a 6809-based system by following the same route.

A NEW START

The new computer is called the Dragon 32 and hails from South Wales, courtesy of Dragon Data who are building the system for Mettoy — the well-known toy makers. On the surface it simply appears to be a 6809-based system with colour graphics and 32K of user memory. Added features are the ability to plug in ROM-based cartridges, to attach joysticks and add a limited number of peripherals through the various ports. If, at this point, you are beginning to feel a slight sense of ***dejà vu*** then take a brief bow. The system is aimed directly at the home market and, on price at least, must be taken as a competitor to the Texas Instruments TI-99/4A, the Atari 400 and the BBC Model A systems.

I mentioned earlier that the system is designed from the standard range of support devices for the 6809 CPU. Well, there are only two other 6809-based systems currently on the market: the Fujitsu triple processor system which can be discounted as it is very much more powerful; and the Tandy Color Computer which we reviewed in April of this year. The similarity between the Tandy and the Dragon 32 is almost uncanny and the reason is not simply because the same chips have been used.

I don't know how Tandy produced the design for the Color Computer but the Dragon 32 was designed with the aid of the PAT Centre, a high technology design group who have been responsible for such devices as Moore and Wright's digital micrometer. As far as I can unravel the story, the basic specification was taken to them with the brief to produce a result from off-the-peg components. Time being of the essence, they appear to have opted for the standard chip set approach and then equipped the resulting hardware with the only commercially available 6809-coded version of BASIC, Microsoft Extended Colour BASIC.

THE INSIDE STORY

The Dragon 32 arrives in a single box complete with power supply, TV lead, manual and quick reference chart. (Don't waste time looking for the cassette lead, it's an extra!) The first thing that strikes you about the system is that it has a 'proper' keyboard although the quality of the particular unit chosen is a little dubious.

The system is enclosed in a cream plastic box which is considerably larger than one might have expected. Quite why they made it this big is beyond me, it could have been at least an inch thinner and nearly the same reduction could have been made in width too. The power supply's transformer is external and there is adequate ventilation, so overheating is unlikely to be the reason. Still, it's a nice chunky case and styled so that it looks narrower than it really is because all the sockets are recessed at the side.

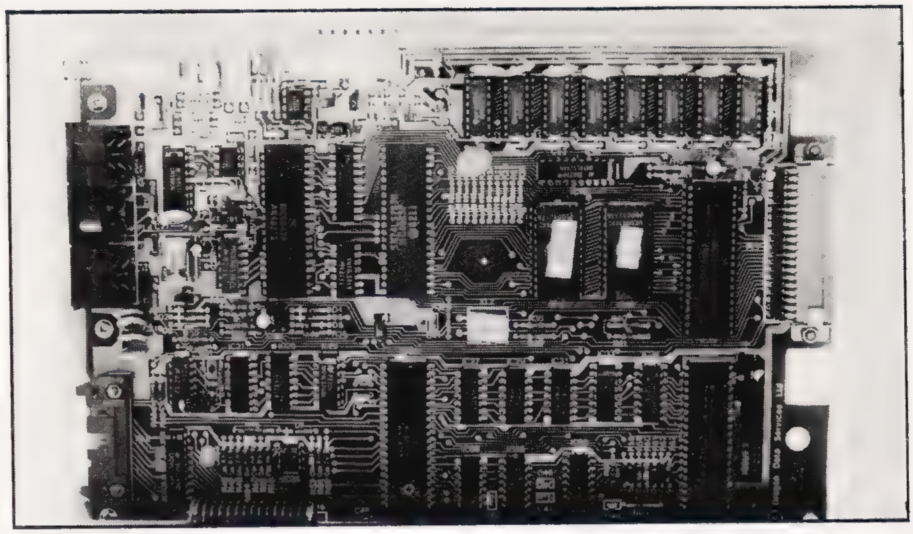
Inside the box (no mention appears in any of the documentation to dissuade you from undoing the screws but I don't recommend it unless you're certain of what you're doing) the layout is almost clinically neat. Excluding the keyboard assembly there are two PCBs, one holding the logic and the other, the regulator circuitry and the modulator. The latter is larger than ●

usually found as it allows the sound channel to be heard through the TV speaker. Connection to the TV is made by a conventional phono to UHF lead which uses considerably better quality cable than most, potentially removing some of the interference caused by stray mains cables and the like. If you don't fancy suffering the degraded quality pictures from a TV, you can take a monitor feed directly from the RGB drive circuitry. Although no connection details are given in the manual, it would appear to be a straight RGB plus sync output.

The main PCB is equipped with all the expected devices and even uses the twin video processing chips found in the Tandy, the SAM and VDG which we covered in detail when we reviewed the Color Computer. The RAM is provided in the form of eight Hitachi 4864 chips and there is a total of 16K of ROM provided by two 2716s. The 6809, the two ROMs and the eight RAMs are all socketed, none of the other devices are. One interesting point is the provision of a number of 'patches' on the layout, these are in the vicinity of the RAM chips and it is possible that an alternative memory capacity system could be produced using pin compatible devices. It would, at least in theory, be possible to use the new 64K by 1 RAMs to produce a 64K Dragon but whether this is something planned I cannot say.

TURN ON

Readers who are familiar with the TRS-80 range of systems might be hoping that the format of the text screen found on the Dragon 32 would be an improvement. No such luck, it's still 16 lines of 32 characters in text mode with no lower case letters, reversed upper case being used instead. Other screen formats include a low resolution plotting capability of 32 by 64 pixels and a high resolution mode of 192 by 256 points. A total of 16 predefined graphics shapes are available, all the variations of a two by two matrix, but these are supplied in eight colour options as some form of compensation. The same eight colours can be defined as background colours for the text screen area, although in text mode only green and black are available as the foreground colour depending on the background selected. The displayed colour picture is of reasonable quality but nothing exceptional. It has been tested on a Philips and an Hitachi portable but the best picture was obtained on my own 22" Ferguson, the TX chassis series proving itself once again.



The main PCB shows the small number of ICs used. The socket at the right-hand side is the cartridge port.

Slight to noticeable colour fringing occurs and there is some sound pickup too, but the main objection is that the primary colours are not clean; red, blue and green should be red, blue and green and not 'off' shades.

The initial screen display simply announces the machine and its version of BASIC. What it does not tell you is how much memory you have available. Typing PRINT MEM returns a value of around 24K which might seem a little surprising since you just bought a 32K computer! The missing 8K of RAM hasn't really vanished, it is being used for the system variables and to create the high resolution graphics areas. While this means less space for you to program in, it does mean that when you come to use the high resolution graphics your memory doesn't shrink dramatically like some other systems we could mention!

Screen editing is through a standard Microsoft line editor system which is initiated by the command EDIT<linenumber> All the usual commands operate and you either like or hate it depending on what you're used to. Bulk line deletion and program renumbering are available under BASIC although automatic line numbering is not. The usual trace functions, TRON and TROFF (Walt Disney take note), are included.

For those into data handling the cassette interface can be used for data files through BASIC although the reliability of the system is not particularly good. The interface seems to be slightly level sensitive but my main criticism would have to be the lack of decent messages, single letters displayed on the screen don't count as messages in my book! The main stumbling point over the cassette interface is the lack of any supplied lead and, as the manual fails to give connection details for the frustrated DIY-er, Fig. 1 should be welcome. There are only two interesting commands on the cassette side: SKIPF which allows you to skip over the named file in order to position the tape for recording or loading files which are not at the beginning; and MOTOR which allows the cassette motor to be controlled by the keyboard and saves having to keep unplugging the remote control lead.

Possibly the only remaining function, other than the graphics which I'll cover in a moment, is the ability to halt a program at any point during execution by pressing Shift @. Pressing any other key, excluding Break (although this is not made clear in the manual) restarts the program so you can take a break in the middle of that dogfight to answer the 'phone or perform other necessary functions.

BASIC GRAPHICS

The Microsoft Extended Colour BASIC implemented on the Dragon 32 is as complete an example of microcomputer BASIC for this level of machine as any you'll find. It supports all the normal BASIC

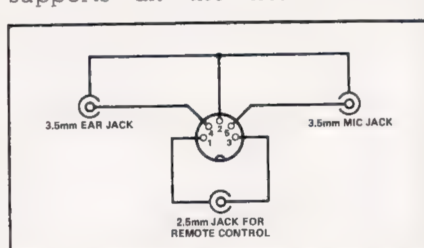
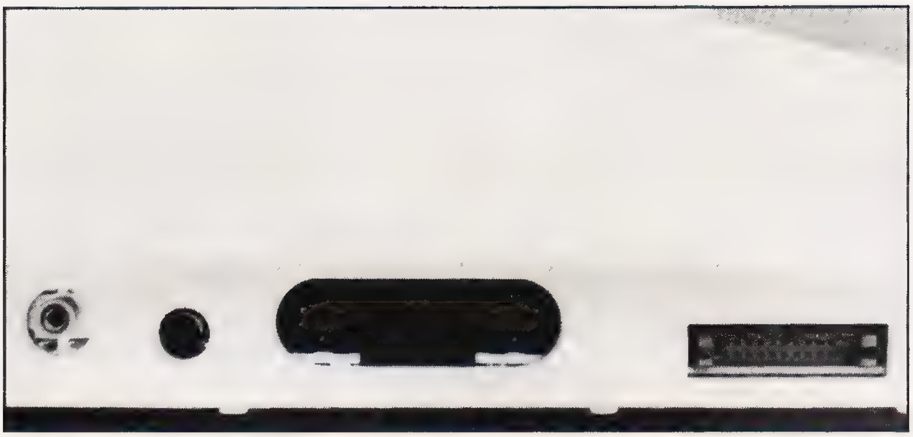
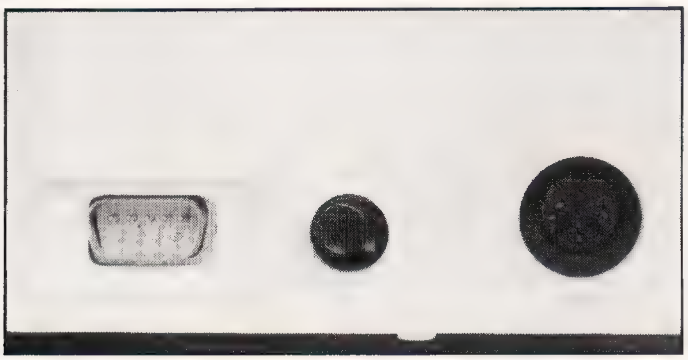


Fig. 1. The connections to the cassette recorder socket for those wishing to make their own leads.





Above: The left-hand side sockets include UHF, two joystick ports and a cassette connector plus the printer port. The black button is the Reset.

Left: The rear panel features the power inlet, power switch and monitor output.

functions, including IF...THEN... ELSE, as well as offering a comprehensive colour graphics command set. Full line drawing with both absolute and relative positioning is available and the single LINE command can be extended to produce rectangles, draw in either foreground or background colour and even fill in a completed box. For filling larger areas of the screen with colour the PAINT command can be used but be warned of leaving holes.

If you're into things round, then the CIRCLE command will certainly satisfy all your needs. As well as producing simple rings of given colour and radius at any point on the screen, it can be extended to produce ellipses by changing the height/width ratio parameter or arcs rather than complete circles. All these high resolution commands are just the basic set, animation using the multiple pages of graphics memory and shape tables using the ingenious DRAW command can be mastered with a modicum of experiment and practice.

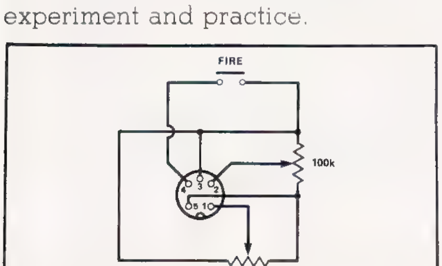


Fig. 2. How the joysticks are assembled together with the necessary connection information.

As an added extra dimension to graphics games the BASIC JOYSTK function allows up to two joysticks to be used, complete with 'fire' buttons. The values returned by the expression can be related to the x and y positions of either stick and it takes a total of six statements to examine both sticks together with the fire buttons. Now, the BASIC isn't exactly slow, (Table 1 gives the Benchmark results) but there must be a better way than this to recover the values which then have to be scaled to suit the screen size in current use.

Wherever you find a home computer, which the Dragon 32 unreservedly is, with colour graphics you almost invariably find sound facilities as well. Simple, single tone noises are produced by the SOUND command where two parameters, frequency and duration, are all that is needed to produce the desired effect through the TV speaker. More complex sound sequences are best constructed under the PLAY function. Here, in a manner similar to that used by the Sharp systems, a complete note passage is programmed into a string which is made up of the note name, octave, duration and volume. Pauses and changes in tempo can also be programmed and as the notation used is similar to 'real' music, it is remarkably easy to use. My personal favourite in the sound department is AUDIO OFF which disables the audio output completely, but then again . . .

INS AND OUTS

The interfacing options of the Dragon 32 appear somewhat limited. The system provides for the basic requirements of a cassette and TV or RGB monitor together with the option joysticks. The only remaining options are the parallel printer port, Centronics compatible and fully supported under BASIC, and the ROM cartridge slot. It is interesting to note that the Tandy Color Computer chose to offer a serial port. A quick count of the available peripheral devices inside the Dragon 32 leads one to wonder just how they managed to create this extra parallel port as there simply aren't enough bits available. The only possible explanation of this is that the printer shares the same PIA as the joysticks; it uses the port as an output whereas the joysticks use it as an input. All the rest is fairly conventional in terms of operation and design but it should be noted that the internal TIMER function will be upset by the use of the cassette interface as it is interrupt driven and not a hardware device.

Further expansion does not, at first glance, seem possible until one remembers the ROM pack slot. All the indications are that most of the address, data and control bus lines should be available through here for expansion. Quite whether the range of Program Paks offered by Tandy will operate in this slot is open to question. The indications are that they should but without complete information on the pin connections of the Dragon 32, I'd rather not suggest that you plug one in to try! If the connectors are the same, expansion to include discs and make use of the 6809's own DOS, FLEX, becomes a strong possibility as many US companies are offering these facilities for the Tandy Color Computer. Tandy themselves offer a range of add-ons but these ignore both FLEX and the S50 bus structure which is so suited to the 6809 CPU.

Currently, the only options available from Dragon Data/Mettoy are the cassette lead, a small choice of ROM packs and a joystick. I've played with their version of a Pacman-type game and while the game was OK, the control offered by the joystick left an awful lot to be desired. Whether the design will be improved or not I do not know but a strong suggestion is to find another source if the joystick you're offered simply flops from side to side like our review sample. For those into building their own joysticks or modifying commercial offerings, the connections shown in Fig. 2 should be of some assistance. You can also use this information to connect other ▶

analogue devices to the Dragon 32 such as temperature sensors and the like.

WORDS OF WISDOM

Two pieces of documentation accompanied our review machine: a manual and a quick reference guide to the BASIC. The manual is written by Richard Wadman with the assistance of University College, Swansea, and, as manuals go, is not too bad. There are a number of small errors which may well have been cleared up by the time the machine hits the streets in a big way, but the main feeling is one of missing information. There are no details of any of the hardware, interface connections or add-ons. Nor are there any facts about the monitor program and how to get 6809-code into the system. There are brief references to the fact that it can be done, you can certainly save machine code programs on tape, but as to how you create them . . .

On the whole, it will satisfy the beginner as it is all clearly laid out and important pages have green edges to highlight their contents. The quick reference guide is a welcome addition as it enables those familiar with another version of BASIC to start trying out the extra commands available without having to rummage through acres of text.

One suggestion I will make though is that if you are really interested in pursuing the BASIC on the Dragon 32, you pay a visit to your local Tandy shop. There you can buy for the princely sum of £3.95 an excellent book called **Going Ahead With Extended Color BASIC** which contains more detail on the Microsoft, provides colour pictures of many of the example programs in action and, best of all, a memory map and a list of operating system entry points. Now, as far as I and another colleague can discover, all these entry points work on the Dragon 32 so you can start to try out simple machine code calls to recover data from peripherals such as the joysticks, etc. One other book you might like to cast your eyes over while in the Tandy shop is the **Color Computer Technical Reference Manual.** Now, I will concede that it is not directly related to your Dragon 32 but it does explain the workings of the SAM and VDG devices and should give an overview at least of the internal operations. Another good reason for buying it is that according to my copy at least, while it costs nearly $15 in the States, it only cost me 99p here!

FACTSHEET	Dragon 32	
CPU	6809	
Clock	0.89MHz	
ROM	16K	
RAM	32K	
Language	Microsoft Extended Colour BASIC	
Keyboard	53 key standard layout	
Display	16 lines of 32 characters on TV or monitor	
	Block mapped graphics on 32 by 64 grid	
	Dot resolution graphics to 192 by 256	
	16 block graphics characters	
	Eight colours plus black	
Cassette	1500 baud with independant motor control	
I/O	Two joystick ports	
	Parallel (Centronics) printer port	
	ROM cartridge slot	
Options	Joystick unit	£10.00
	ROM cartridges	£20.00
	Cassette software	£8.00
	5¼" disc drive SSSD	NYA
	OS9 operating system	NYA
Costs	Dragon 32	£199.50
Manufacturer	Dragon Data Ltd	
	Queensway	
	Swansea Industrial Estate	
	Swansea SA5 4EH	
	0792-586223	

IN THE END

Just what has the Dragon 32 got to offer over its rivals? Well, if you were looking for a home computer to play games with and maybe try a little programming on, it does have the advantage of a reasonable amount of RAM and an almost decent keyboard. The BASIC is powerful enough for domestic use but if you really want a programming tool then BBC BASIC still stands out ahead, although the Model A offers less memory at the price. As an alternative to the Tandy Color Computer it wins on price alone although it certainly doesn't look as nice.

As for its other rivals, the Atari and Texas systems, the choice of ready-to-run games and add-ons possibly tends to weigh against the Dragon 32. Another possible source of concern is that Mettoy have never been in the computer market before whereas both the others have a long pedigree but, in reality, there is little that can go wrong in a system like this that cannot be simply and easily fixed.

All these systems are readily available in the High Street, at least the Dragon 32 should be by now, and as is so often the case, it must come down to personal choice. There is certainly nothing wrong with the Dragon 32 and it offers an alternative and British-made solution to the home computer buyer. Whether it will succeed in making an impact on the market will probably depend on the general availability of both it and its extras and the effectiveness of the current advertising campaign.

Benchmark	**Time**
BM1	1.27
BM2	9.14
BM3	17.70
BM4	19.17
BM5	22.16
BM6	31.07
BM7	44.68
BM8	10.82

Table 1. The Benchmark timings for the Dragon 32. All are in seconds and timed using the internal clock function. Note that BM8 is taken over 100 loops instead of the usual 1,000.

ENTER THE DRAGON

HARDWARE SPECIFICATION

★ 6809E Microprocessor, a great advance on the original 6502 still used by PET, Apple, Atom, Atari 400, BBC Micro, VIC 20
★ 32K RAM memory as standard – At least twice as powerful as other computers at the same price, expandable to 64K
26K user available after 4 pages of high resolution graphics
★ DRAGON 32, unlike most units, gives EXTENDED MICROSOFT COLOUR BASIC as standard
Microsoft basic has become the industry standard (e.g. IBM, Apple, Commodore, Tandy, Atari)
THIS HAS
Advanced graphics features - set, line, draw
Advanced sound feature
Automatic control of cassette recorder
Full editing features – insert, delete, change
★ DISPLAY
9 Colours
5 Different resolutions from 512 points of text 16 × 32
(256 × 192) at high resolution
Home UHF TV set and/or colour monitor
★ KEYBOARD
Professional quality keyboard to the standard of
terminals
Typewriter layout and feel
Guaranteed for 20 million key depressions
★ SIMPLE PLUG-IN CONNECTION FOR
Joystick controllers
Audio cassette recorder (inc. Stop/Start)
Printer (Centronics parallel)
Games cartridges
★ 160 page "BASIC" training manual – FREE

PROGRAMMING STATEMENTS AND COMMAND

MATHEMATICAL AND LOGICAL OPERATORS

Symbol	Operation
	Exponentiation
	Unary minus
*	Multiplication
	Division
+	Addition
	Subtraction
	Greater than
<	Less than
	Equal to
<>	Not equal to
	Greater than or equal to
<	Less than or equal to
NOT	logical NOT
AND	logical AND
OR	logical OR

BASIC LANGUAGE STATEMENTS

CLEAR	LINE INPUT
CLS	ON . . . GOSUB
DATA	ON . . GOTO
DEF	POKE
DEFUSR	PRINT
DIM	PRINT TAB
END	PRINT USING
EXEC	PRINT @
FOR TO STEP NEXT	READ
GOSUB	REM
GOTO	RESTORE
IF	RETURN
INPUT	STOP
LET	

SOUND GENERATION STATEMENTS

PLAY	SOUND

CASSETTE RECORDER CONTROL STATEMENTS

AUDIO	CLOSE	EOF (– 1)	OPEN
CLOAD	CSAVE	INPUT	PRINT
CLOADM	CSAVEM	MOTOR	SKIPF

PRINTER CONTROL STATEMENTS

LLIST	OPEN	PRINT

SYSTEM COMMANDS

CONT	LIST	RUN
DEL	NEW	TROFF
EDIT	RENUM	TRON

GRAPHICS STATEMENTS

CIRCLE (x,y)	LINE	PCOPY	PUT
COLOUR	PAINT	PMODE	RESET
DRAW	PCLEAR	PRESENT	SCREEN
GET	PCLS	PSET	SET

STRING FUNCTIONS

ASC	INKEY$	LEN	STRING$
CHR$	INSTR	MID$	STR$
HEX$	LEFT$	RIGHT$	VAL

NUMERIC FUNCTIONS

ABS	INT	POINT	SQR
ATN	JOYSTK	POS	TAN
COS	LOG	PPOINT	TIMER
EXP	MEM	RND	USR
FIX	PEEK	SGN	VAPTR

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Meteoroids – Pick your way through the treacherous

CASSETTES
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Compendium of Applications – A selection of routines to get the most from your Dragon
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Madness and the Minotaur – An adult strategy game in real time
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M James

CONVERTING MINI-CALC

Last month we presented our NASCOM-based spreadsheet program, this month we offer some suggestions for its conversion to other systems.

Mini-Calc is a really useful program and I would think that many of you who have NASCOMs will no doubt jump at the chance to buy it on cassette tape. Owners of other Z80 based machines will also be eager to modify it to run with their versions of BASIC. But what about the rest of you? It is such an attractive program that many without Z80 systems may be thinking about trying to convert it. This is certainly possible and it is then worth obtaining a copy of the assembly listing. In your case, however, more work will be required before you can actually run Mini-Calc — but it will greatly increase your understanding of computing.

COMPUTER CHALLENGE

Converting any program from one computer language to another is always a challenge, and this is especially true when the languages concerned are low level. Some of you may think that it is difficult enough to learn one machine language let alone the two that are necessary to undertake such a conversion, but let me assure you that acquiring a second machine language is easy. Once you have understood the concepts of writing assembler then learning assembler for a new machine is just a matter of discovering what registers, addressing modes and instructions the machine has.

It is usually better to tackle the problem in the order stated. The first thing to do is to examine what registers the new machine has and to try to establish what sort of registers they are, ie what they are mainly used for — arithmetic, addressing, condition code, etc. Next, make a list of the various ways that you can specify addresses, the so-called addressing modes of the machine; the register set and the addressing modes are the two things that give any machine its distinctive character. The final step is to look at what sort of instructions the new machine has, being careful to notice if there are any restrictions on the way addressing modes can be combined with the instructions. For example, the 6502 does not allow LDY to be combined with indexing on the Y register, ie LDY NUM,Y is not allowed although LDY NUM,X is. Similarly, the Z80 does not allow extended addressing to be used in a register load instruction unless the register is the accumulator, ie LD B, (123) is not allowed but LD A, (123) is.

Notice that in both the above examples, the restriction on the use of the addressing mode with a particular instruction is entirely arbitrary. A well designed micro should allow any addressing mode to be used with any instruction that it makes any sense of. Unfortunately, very few micros possess this logical 'uniformity' (the 6800/6809 being a welcome exception) and the only thing to do is to take note of the arbitrary exclusions. I find that the best thing to do is to assume that you can use any addressing mode with any instruction and then make a list of those that you can't and pin it up next to the machine.

There is one last problem in learning a new language which is quite trivial compared to the rest but in practice is the biggest cause of bugs when you first start to program. Different assemblers have different ways of expressing the same thing. For example, on the 6502, LDA 20 means load the A register with the contents of memory location 20 but in Z80 code LDA (20) means the same thing. These small differences are trivial but it can be difficult to change from one convention to another.

WHICH ADDRESS?

Assuming that you have mastered the two assembly languages necessary for converting Mini-Calc then how do you go about it? To make our discussion simpler, for the rest of this article we will assume that the machine on which you are trying to implement Mini-Calc is 6502 based. Apart from the problem of converting Z80 code, Mini-Calc offers an additional problem in that it uses subroutines in Xtal BASIC. It is certain that whatever BASIC you are using will not use the same addresses as Xtal BASIC for similar routines. It is likely that it will have subroutines that do the same job (as all BASIC interpreters do roughly the same sort of thing) but you will have to find out where they are and *exactly* how they can be used. For some machines this is easy. You can, for example, find a list of BASIC subroutines for the PET in either **The PET Revealed** or **Programming the PET/CBM**. Using these sources, you will find that the Xtal routine FINDLN at $19B2 is equivalent to the routine FINDLN routine at $C522 in BASIC 1, at $C55B in BASIC 2 and $B5A3 in BASIC 4. Before you start converting Mini-Calc it is important to have identified equivalent routines in your version of BASIC and be aware of the way that they differ from Xtal routines.

The actual conversion of Z80 assembly language to 6502 is relatively easy if you organise yourself before you start. It is possible to do the conversion by starting at the beginning and converting each line in turn; however, you do run the risk of getting near to the end of the conversion and then encountering something unexpected that you cannot convert without changing most of what you have already done. To misquote a well-known quiz master — *do not start until you are sure you can finish.*

FIRST THINGS FIRST

The first problem to solve is that the Z80 has more internal registers than almost any other micro and certainly more than the 6502. If it was the other way around, it would be possible to assign a Z80 register to each of the 6502's registers and still have some left over! The best solution is to assign an area of memory to act as each of the Z80 registers and then write subroutines which will manipulate these areas of memory in the same way as Z80 instructions manipulate the registers. This is not an easy task but it is not necessary to write an equivalent subroutine for ***every*** Z80 operation unless you intend to convert programs on a regular basis. All you have to do is to work out an equivalent for each instruction used in Mini-Calc. It doesn't really matter where you place the area of memory reserved for the dummy Z80 registers, but because the HL pair is used as an indirection register, it makes life easy if it is located in the 6502 Page zero area. The reason for this is that the 6502 only allows indirection through Page zero addresses. You can translate Z80 instructions like LD D,(HL) into three 6502 instructions:

```
LDX #HL
LDA (#0,X)
STA D
```

In the case of the 6502, HL and D are memory locations and HL is in Page zero. Another problem to be aware of when changing Z80 code to 6502 is the different way that the index registers IX and IY (in the Z80 case) and X and Y (in the 6502 case) are used. The function of these registers is roughly the same for both machines so it is tempting to try to directly translate instructions involving index registers without using a dummy register. This is a good idea as long as you notice that IX and IY are 16-bit registers and X and Y are eight bit registers. The 6502 converts the number stored in the index register into a 16-bit address by adding it to a 16-bit offset, but the Z80 uses an eight-bit offset. The role of the index register in the 6502 is to hold an adjustment to the address specified in the offset while in the Z80, it is the other way round — the address is in the index register and the adjustment is in the offset! So, when you meet instructions like:

```
LD IY,DECTAB
LD D,(IY+1)
INC IY
```

they should be translated to:

```
LDY #1
LDA DECTAB,Y
STA D
INC Y
```

GO YOUR OWN WAY

I could go on listing interesting and clever ways of changing Z80 code into 6502 code but I have no doubt that you will discover your own particular methods. The most important thing is that you understand the general idea of using memory locations as dummy registers and then take advantage of the similarities between the two machines to simplify what you are doing.

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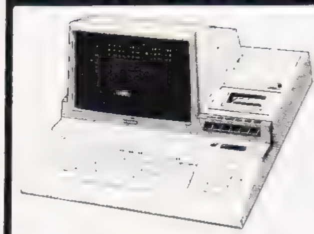

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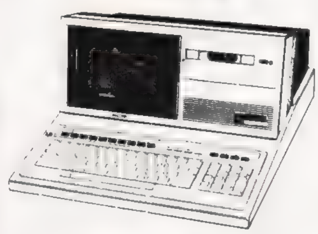

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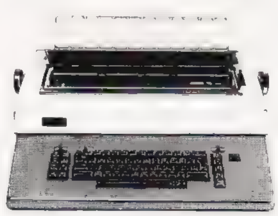

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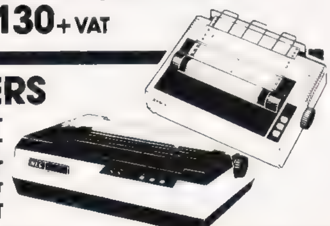

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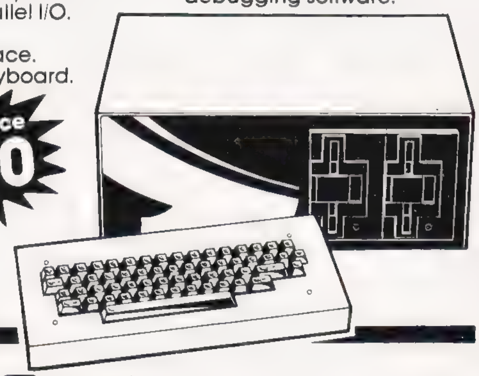

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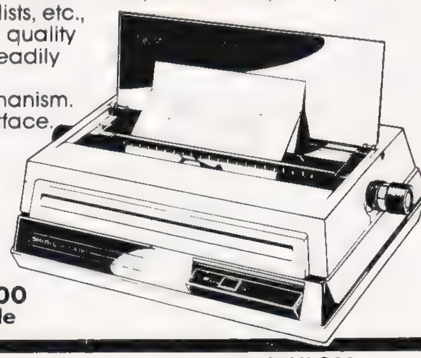

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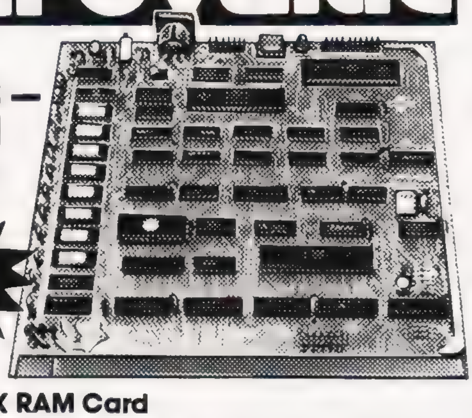

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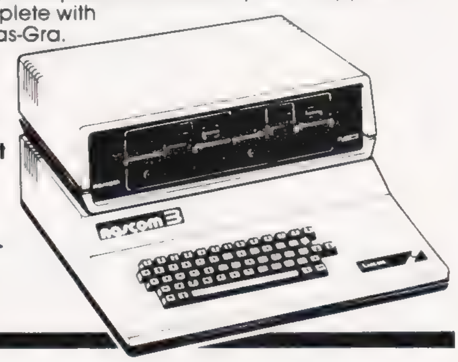

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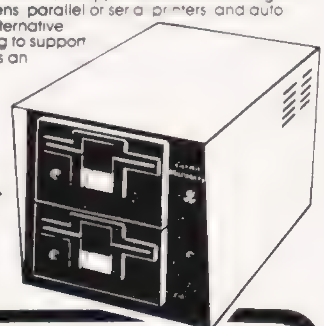

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If you thought that loading software from disc was fast you've never downloaded from another machine!

This article describes a machine code utility to let two PETs, a PET and VIC or two VICs exchange programs via a link between the user ports. This link involves no additional circuitry, merely a 10 core screened cable with the appropriate connector on each end (see Fig 1).

The general procedure would be to load the machine code, via a BASIC loader, into both machines. Programs may then be exchanged at speeds in excess of disc loads by giving a SYS command on each machine:

```
On an 8K PET  SYS 7936,S to send
              SYS 7936,R to receive

On a VIC + 3K SYS 7424,S to send
              SYS 7424,R to receive
```

As the machine code is loaded into high memory in each case, it needs protecting. If loaded in Hex using the monitor, it contains code to protect itself, but if loaded from a BASIC loader it will need protecting from BASIC prior to running with:

```
PET as above  POKE 52,0:POKE 53,30
              POKE 48,0:POKE 49,30
              CLR
VIC as above  POKE 51,0:POKE 52,29
              POKE 55,0:POKE 56,29
              CLR
```

It is vital to start the receiver first, both out of consideration for the hardware, as both user ports could be configured as outputs, and for the need to catch the first byte of the transfer.

THE IDEA

The idea and requirement for these routines arose after the acquisition of a VIC computer without a cassette player. Therefore, this computer had to share a cassette player with a PET system and it always seemed that the cassette was on the wrong machine. The power should be turned off before plugging in or unplugging the cassette, or anything else for that matter, as the VIA lines are unbuffered and the VIA chip is easily blown by accidental shorts. Turning the power off also loses the program. Using the Communicator program loaded into the VIC from the cassette and into the PET from disc, it is possible to exchange programs at will, very quickly.

Listing 1 gives both the source and object code for the PET version of the program. As it is symbolic, it may be easily relocated by readers with an assembler. The program calls three ROM routines that would have to be changed for other than New ROMs (3.0); what I believe to be BASIC 4.0 versions are given in the listing. The VIC version is structurally identical, though the user port is mapped to a different address and is the 'B' side of the VIA, whereas in the PET the 'A' side and CB2 are used. This entails some changes to the handshaking of the data across the link. Listing 2 gives the VIC version assembled for a VIC with a 3K memory cartridge, though this again is easily relocated for other VIC configurations. Listing 3 gives a BASIC loader version for the VIC described above and Listing 4 gives the BASIC loader for a 4.0 ROM 8K PET.

HOW THE PROGRAM WORKS

The two machine code programs might look fairly fearsome but they are structured for simplicity. The main sections will be discussed in more detail below.

PROTECT This section alters the top of memory pointers. This could be done from BASIC to save a few bytes if memory is short.
START This section looks beyond the SYS for the 'S' or 'R' signifying Send or Receive. If neither are present it will jump to the BASIC Syntax Error routine. Depending on whether an 'S' or an 'R' follows the SYS, the VIA data lines are set up for input or output.
SETUP This section first moves the CHRGET pointer past the 'S' or 'R' and then sets up the ACR (Auxilliary Control Register) and PCR (Peripheral Control Register) with the correct bit pattern for using CB2 as Data Valid/Busy and

CA1 (CB1 on VIC) as data strobes.
SETBASPOINT Takes a copy of the 'Start of BASIC' vector and saves it at BASPOINT. It then checks the DDRA (Data Direction Register) and branches to either LISTEN or TRANSMIT.
LISTEN The first part signals to the other CBM machines that it is ready to receive data. The next subroutine waits for the data strobe from the other CBM and then loads the data from the VIA into the BASIC text area pointed to by BASPOINT. Next, a check is made to see if the end of the program has been received. (The end of a program is marked by three consecutive zeroes.) If the end is found, the program jumps to the ENDFOUND routine. If it is not the end, the program loops back to the beginning of the LISTEN routine.
TRANSMIT This is similar to LISTEN but in reverse. It waits for the receiver to signal ready and then loads the data from the BASIC text area into the VIA. A strobe then indicates to the receiver that the data is valid. A similar endcheck to LISTEN is performed and if it has not reached the end, it loops back for the next character. On finding the end the program branches to SENDEND.
ENDFOUND This section realigns the pointers so that BASIC knows the length of the transmitted program. A similar jump to CLR completes the LISTEN routine.

The rest of the program consists of the various subroutines called by the main program above.

USREADY Sends a pulse on the CB2 line to the CA1/CB1 input of the other machine, to signal either Busy Clear or Data Valid.
THEMREADY Waits for a pulse on CA1/CB1 as above.
INCTXT Increments the CHRGET pointer and loads the next character from the BASIC text.
INCPTR Increments the BASPOINT pointer.
ENDCHECK This routine looks back over the received characters to check for three zeroes and sets the end flag at $00 accordingly.
DECPTR Decrements the pointer used by ENDCHECK to look back through the BASIC text.
CHECKEND Similar to ENDCHECK but the routine looks forward to trap the end condition before it is transmitted.
SENDEND Transmits three zeroes.

TESTING THE PROGRAM

When using machine code, all the protection built into BASIC is lost and it is easy to set the computer into a condition where it is stuck in a loop, 'crashed' in the vernacular. In order to be able to interrupt the program with the 'Stop key, there needs to be a call in the main loop to either $F30F, which checks for the Stop key and then performs a stop, or to $F301 which tests the Stop key and sets the zero flag. (This enables any tidying up to be done before a program exit.) However, in order to use these routines, the interrupts must be enabled which does slow up the data transmission considerably. In the final version given here, there is no provision for using the Stop key, so errors will probably cause a crash and necessitate turning both computers off. It is, therefore, important to save a copy of the program ***before*** testing.

As two machines and two programs are involved there is at least twice the scope for error. The most likely source of error, apart from copying errors, is having the interrupt flags set incorrectly before starting. The RECEIVE routine clears the IFR before starting. The RECEIVE routine clears the IFR before starting, though as a result of correcting a mistake halfway through a transmission, it is possible to get locked in a loop with each computer waiting for the other to send 'Ready'. Taking care in running RECEIVE first should help here.

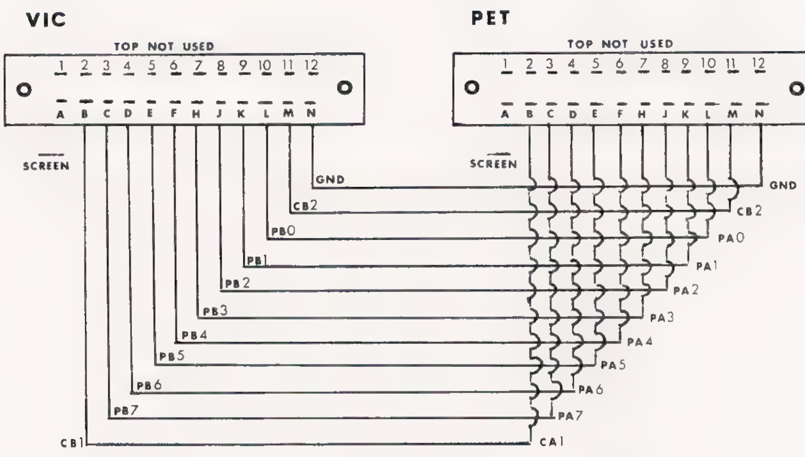

Fig. 1. A detailed illustration of the 10-core screened cable connection necessary to link a VIC to a PET.

```
E840  VIAORG=$E840 LOCATION OF VIA IN MEMORY
E840  BREG=VIAORG
E841  HAND=VIAORG+1
E842  DDRB=VIAORG+2
E843  DDRA=VIAORG+$03
E84B  ACR=VIAORG+$0B
E84C  PCR=VIAORG+$0C
E84D  IFR=VIAORG+$0D
E84F  AREG=VIAORG+$0F
C579  CLR=$C579 BASIC CLR ROUTINE .......... ($B5EC)
C439  REBUILD=$C439 REBUILD BASIC POINTERS . ($B4B6)
CE03  SYNERR=$CE03 SYNTAX ERROR ............ ($BF00)
0001  BASPOINT=$01 POINTER FOR BASIC TEXT
0028  BASSTART=$28 START OF BASIC POINTER
0034  MEMTOP=$34 TOP OF MEMORY POINTER
002A  BASEND=$2A  END  OF            BASIC POINTER
0077  TXTPTR=$77 CHRGET POINTER
0088  RNDSEED=$88 TEMPORARY STORAGE OF A POINTER
033A              ;
033A              *=$1F00
1F00              ;
1F00              ;**************************************************
1F00              ;*
1F00              ;* MAIN PROGRAM
1F00              ;*
1F00              ;**************************************************
1F00              ;
1F00  A200        PROTECT     LDX  #<PROTECT     PROTECT M/C
1F02  A91F                    LDA  #>PROTECT
1F04  8535                    STA  MEMTOP+1
1F06  8634                    STX  MEMTOP
1F08  20A81F      START       JSR  INCTXT
1F0B  C952                    CMP  #'R           IS IT RECEIVE
1F0D  F007                    BEQ  RECEIVE
```

```
1F0F  C953                  CMP  #'S
1F11  F00B                  BEQ  SEND
1F13  4C03CE                JMP  SYNERR
1F16  A900     RECEIVE      LDA  #$00
1F18  8D43E8                STA  DDRA
1F1B  4C231F                JMP  SETUP
1F1E  A9FF     SEND         LDA  #$FF
1F20  8D43E8                STA  DDRA
1F23  20A81F   SETUP        JSR  INCTXT
1F26  78                    SEI
1F27  AD4BE8                LDA  ACR
1F2A  0901                  ORA  #$01
1F2C  29E3                  AND  #$E3
1F2E  8D4BE8                STA  ACR
1F31  AD4CE8                LDA  PCR
1F34  09C1                  ORA  #$C1
1F36  29DF                  AND  #$DF
1F38  8D4CE8                STA  PCR
1F3B  A528     SETBASPOINT  LDA  BASSTART
1F3D  8501                  STA  BASPOINT
1F3F  A529                  LDA  BASSTART+1
1F41  8502                  STA  BASPOINT+1
1F43  AD43E8                LDA  DDRA
1F46  D01D                  BNE  TRANSMIT
1F48  AD41E8                LDA  HAND
1F4B  20921F   LISTEN       JSR  USREADY
1F4E  20A01F                JSR  THEMREADY
1F51  A000                  LDY  #$00
1F53  AD41E8                LDA  HAND
1F56  9101                  STA  (BASPOINT),Y
1F58  20BA1F                JSR  ENDCHECK
1F5B  A500                  LDA  $00
1F5D  D024                  BNE  ENDFOUND
1F5F  20B31F                JSR  INCPTR
1F62  4C4B1F                JMP  LISTEN
1F65  20A01F   TRANSMIT     JSR  THEMREADY
1F68  A000                  LDY  #$00
1F6A  B101                  LDA  (BASPOINT),Y
1F6C  8D41E8                STA  HAND
1F6F  20921F                JSR  USREADY
1F72  20B31F                JSR  INCPTR
1F75  20E11F                JSR  CHECKEND
1F78  A500                  LDA  $00
1F7A  F0E9                  BEQ  TRANSMIT
1F7C  20EF1F                JSR  SENDEND
1F7F  58                    CLI
1F80  4C79C5                JMP  CLR
1F83  A501     ENDFOUND     LDA  BASPOINT
1F85  852A                  STA  BASEND
1F87  A502                  LDA  BASPOINT+1
1F89  852B                  STA  BASEND+1
1F8B  58                    CLI
1F8C  2039C4                JSR  REBUILD
1F8F  4C79C5                JMP  CLR
1F92           ;*****************************************
1F92           ;*
1F92           ;* SUBROUTINES
1F92           ;*
1F92           ;*****************************************
1F92           ;
1F92  AD4CE8   USREADY      LDA  PCR
1F95  09E0                  ORA  #$E0
1F97  8D4CE8                STA  PCR
1F9A  29DF                  AND  #$DF
1F9C  8D4CE8                STA  PCR
1F9F  60                    RTS
1FA0           ;
1FA0  AD4DE8   THEMREADY    LDA  IFR
1FA3  2902                  AND  #$02
1FA5  F0F9                  BEQ  THEMREADY
1FA7  60                    RTS
1FA8           ;
1FA8  A000     INCTXT       LDY  #$00
1FAA  E677                  INC  TXTPTR
1FAC  D002                  BNE  NOCARRY
1FAE  E678                  INC  TXTPTR+1
1FB0  B177     NOCARRY      LDA  (TXTPTR),Y
1FB2  60                    RTS
1FB3           ;
1FB3  E601     INCPTR       INC  BASPOINT
1FB5  D002        .         BNE  NOTCARRY
1FB7  E602                  INC  BASPOINT+1
1FB9  60       NOTCARRY     RTS
1FBA           ;
1FBA  A501     ENDCHECK     LDA  BASPOINT
1FBC  8588                  STA  RNDSEED
1FBE  A502                  LDA  BASPOINT+1
1FC0  8589                  STA  RNDSEED+1
1FC2  A203                  LDX  #$03
1FC4  A000                  LDY  #$00
1FC6  B188     LOOPA        LDA  (RNDSEED),Y
1FC8  D00B                  BNE  NOTEND
1FCA  20DA1F                JSR  DECPTR
1FCD  CA                    DEX
1FCE  D0F6                  BNE  LOOPA
1FD0  A9FF     FOUNDEND     LDA  #$FF
1FD2  8500                  STA  $00
1FD4  60                    RTS
1FD5  A900     NOTEND       LDA  #$00
1FD7  8500                  STA  $00
1FD9  60                    RTS
1FDA           ;
1FDA  C688     DECPTR       DEC  RNDSEED
1FDC  D002                  BNE  NOBORROW
1FDE  C689                  DEC  RNDSEED+1
1FE0  60       NOBORROW     RTS
1FE1           ;
1FE1  A000     CHECKEND     LDY  #$00
1FE3  B101     LOOPB        LDA  (BASPOINT),Y
1FE5  D0EE                  BNE  NOTEND
1FE7  C8                    INY
1FE8  C003                  CPY  #$03
1FEA  90F7                  BCC  LOOPB
1FEC  4CD01F                JMP  FOUNDEND
1FEF           ;
1FEF  A203     SENDEND      LDX  #$03
1FF1  20A01F   LOOPC        JSR  THEMREADY
1FF4  A900                  LDA  #$00
1FF6  8D41E8                STA  HAND
1FF9  20921F                JSR  USREADY
1FFC  CA                    DEX
1FFD  D0F2                  BNE  LOOPC
1FFF  60                    RTS
```

Listing 1. The PET Communicator.

```
9110  VIAORG=$9110 LOCATION OF VIA IN MEMORY
9110  BREG=VIAORG
9111  HAND=VIAORG+1
9112  DDRB=VIAORG+2
9113  DDRA=VIAORG+$03
911B  ACR=VIAORG+$0B
911C  PCR=VIAORG+$0C
911D  IFR=VIAORG+$0D
911F  AREG=VIAORG+$0F
C660  CLR=$C660 BASIC CLR ROUTINE
C533  REBUILD=$C533 REBUILD BASIC POINTERS
CF08  SYNERR=$CF08 SYNTAX ERROR
0001  BASPOINT=$01
002B  BASSTART=$2B
0037  MEMTOP=$37 TOP OF MEMORY POINTER
002D  BASEND=$2D
007A  TXTPTR=$7A CHRGET POINTER
```

```
100  READ L,H:FOR I=L TO H:READ DT:POKE I,DT:NEXT
1000 DATA 7424, 7679
1010 DATA 162,0,169,29,133,56,134,55,32,168,29,201,82,240,7,201
1020 DATA 83,240,11,76,8,207,169,0,141,18,145,76,35,29,169,255
1030 DATA 141,18,145,32,168,29,120,173,27,145,9,2,41,227,141,27
1040 DATA 145,173,28,145,9,208,41,223,141,28,145,165,43,133,1,165
1050 DATA 44,133,2,173,18,145,208,29,173,16,145,32,146,29,32,160
1060 DATA 29,160,0,173,16,145,145,1,32,186,29,165,0,208,36,32
1070 DATA 179,29,76,75,29,32,160,29,160,0,177,1,141,16,145,32
1080 DATA 146,29,32,179,29,32,225,29,165,0,240,233,32,239,29,88
1090 DATA 76,96,198,165,1,133,45,165,2,133,46,88,32,51,197,76
1100 DATA 96,198,173,28,145,9,224,141,28,145,41,223,141,28,145,96
1110 DATA 173,29,145,41,16,240,249,96,160,0,230,122,208,2,230,123
1120 DATA 177,122,96,230,1,208,2,230,2,96,165,1,133,139,165,2
1130 DATA 133,140,162,3,160,0,177,139,208,11,32,218,29,202,208,246
1140 DATA 169,255,133,0,96,169,0,133,0,96,198,139,208,2,198,140
1150 DATA 96,160,0,177,1,208,238,200,192,3,144,247,76,208,29,162
1160 DATA 3,32,160,29,169,0,141,16,145,32,146,29,202,208,242,96
```

Listing 3. BASIC loader for VIC.

```
008B  RNDSEED=$8B TEMPORARY POINTER STORAGE
033A              ;
033A              *=$1D00
1D00              ;
1D00              ;****************************************
1D00              ;*
1D00              ;* MAIN PROGRAM
1D00              ;*
1D00              ;****************************************
1D00              ;
1D00  A200        PROTECT     LDX  #<PROTECT
1D02  A91D                    LDA  #>PROTECT
1D04  8538                    STA  MEMTOP+1
1D06  8637                    STX  MEMTOP
1D08  20A81D      START       JSR  INCTXT
1D0B  C952                    CMP  #'R
1D0D  F007                    BEQ  RECEIVE
1D0F  C953                    CMP  #'S
1D11  F00B                    BEQ  SEND
1D13  4C08CF                  JMP  SYNERR
1D16  A900        RECEIVE     LDA  #$00
1D18  8D1291                  STA  DDRB
1D1B  4C231D                  JMP  SETUP
1D1E  A9FF        SEND        LDA  #$FF
1D20  8D1291                  STA  DDRB
1D23  20A81D      SETUP       JSR  INCTXT
1D26  78                      SEI
1D27  AD1B91                  LDA  ACR
1D2A  0902                    ORA  #$02
1D2C  29E3                    AND  #$E3
1D2E  8D1B91                  STA  ACR
1D31  AD1C91                  LDA  PCR
1D34  09D0                    ORA  #$D0
1D36  29DF                    AND  #$DF
1D38  8D1C91                  STA  PCR
1D3B  A52B        SETBASPOINT LDA  BASSTART
1D3D  8501                    STA  BASPOINT
1D3F  A52C                    LDA  BASSTART+1
1D41  8502                    STA  BASPOINT+1
1D43  AD1291                  LDA  DDRB
1D46  D01D                    BNE  TRANSMIT
1D48  AD1091                  LDA  BREG
1D4B  20921D      LISTEN      JSR  USREADY
1D4E  20A01D                  JSR  THEMREADY
1D51  A000                    LDY  #$00
1D53  AD1091                  LDA  BREG
1D56  9101                    STA  (BASPOINT),Y
1D58  20BA1D                  JSR  ENDCHECK
1D5B  A500                    LDA  $00
1D5D  D024                    BNE  ENDFOUND
1D5F  20B31D                  JSR  INCPTR
1D62  4C4B1D                  JMP  LISTEN
1D65  20A01D      TRANSMIT    JSR  THEMREADY
1D68  A000                    LDY  #$00
1D6A  B101                    LDA  (BASPOINT),Y
1D6C  8D1091                  STA  BREG
1D6F  20921D                  JSR  USREADY
1D72  20B31D                  JSR  INCPTR
1D75  20E11D                  JSR  CHECKEND
1D78  A500                    LDA  $00
1D7A  F0E9                    BEQ  TRANSMIT
1D7C  20EF1D                  JSR  SENDEND
1D7F  58                      CLI
1D80  4C60C6                  JMP  CLR
1D83  A501        ENDFOUND    LDA  BASPOINT
1D85  852D                    STA  BASEND
1D87  A502                    LDA  BASPOINT+1
1D89  852E                    STA  BASEND+1
1D8B  58                      CLI
1D8C  2033C5                  JSR  REBUILD
1D8F  4C60C6                  JMP  CLR
1D92              ;****************************************
1D92              ;*
1D92              ;* SUBROUTINES
1D92              ;*
1D92              ;****************************************
1D92              ;
1D92  AD1C91      USREADY     LDA  PCR
1D95  09E0                    ORA  #$E0
1D97  8D1C91                  STA  PCR
1D9A  29DF                    AND  #$DF
1D9C  8D1C91                  STA  PCR
1D9F  60                      RTS
1DA0              ;
1DA0  AD1D91      THEMREADY   LDA  IFR
1DA3  2910                    AND  #$10
1DA5  F0F9                    BEQ  THEMREADY
1DA7  60                      RTS
1DA8              ;
1DA8  A000        INCTXT      LDY  #$00
1DAA  E67A                    INC  TXTPTR
1DAC  D002                    BNE  NOCARRY
1DAE  E67B                    INC  TXTPTR+1
1DB0  B17A        NOCARRY     LDA  (TXTPTR),Y
1DB2  60                      RTS
1DB3              ;
1DB3  E601        INCPTR      INC  BASPOINT
1DB5  D002                    BNE  NOTCARRY
1DB7  E602                    INC  BASPOINT+1
1DB9  60          NOTCARRY    RTS
1DBA              ;
1DBA  A501        ENDCHECK    LDA  BASPOINT
1DBC  858B                    STA  RNDSEED
1DBE  A502                    LDA  BASPOINT+1
1DC0  858C                    STA  RNDSEED+1
1DC2  A203                    LDX  #$03
1DC4  A000                    LDY  #$00
1DC6  B18B        LOOPA       LDA  (RNDSEED),Y
1DC8  D00B                    BNE  NOTEND
1DCA  20DA1D                  JSR  DECPTR
1DCD  CA                      DEX
1DCE  D0F6                    BNE  LOOPA
1DD0  A9FF        FOUNDEND    LDA  #$FF
1DD2  8500                    STA  $00
1DD4  60                      RTS
1DD5  A900        NOTEND      LDA  #$00
1DD7  8500                    STA  $00
1DD9  60                      RTS
1DDA              ;
1DDA  C68B        DECPTR      DEC  RNDSEED
1DDC  D002                    BNE  NOBORROW
1DDE  C68C                    DEC  RNDSEED+1
1DE0  60          NOBORROW    RTS
1DE1              ;
1DE1  A000        CHECKEND    LDY  #$00
1DE3  B101        LOOPB       LDA  (BASPOINT),Y
1DE5  D0EE                    BNE  NOTEND
1DE7  C8                      INY
1DE8  C003                    CPY  #$03
1DEA  90F7                    BCC  LOOPB
1DEC  4CD01D                  JMP  FOUNDEND
1DEF              ;
1DEF  A203        SENDEND     LDX  #$03
1DF1  20A01D      LOOPC       JSR  THEMREADY
1DF4  A900                    LDA  #$00
1DF6  8D1091                  STA  BREG
1DF9  20921D                  JSR  USREADY
1DFC  CA                      DEX
1DFD  D0F2                    BNE  LOOPC
1DFF  60                      RTS
```

Listing 2. The VIC Communicator.

```
100  READ L,H:FOR I=L TO H:READ DT:POKE I,DT:NEXT
1000 DATA 7936, 8191
1010 DATA 162,0,169,31,133,53,134,52,32,168,31,201,82,240,7,201
1020 DATA 83,240,11,76,3,206,169,0,141,67,232,76,35,31,169,255
1030 DATA 141,67,232,32,168,31,120,173,75,232,9,1,41,227,141,75
1040 DATA 232,173,76,232,9,193,41,223,141,76,232,165,40,133,1,165
1050 DATA 41,133,2,173,67,232,208,29,173,65,232,32,146,31,32,160
1060 DATA 31,160,0,173,65,232,145,1,32,186,31,165,0,208,36,32
1070 DATA 179,31,76,75,31,32,160,31,160,0,177,1,141,65,232,32
1080 DATA 146,31,32,179,31,32,225,31,165,0,240,233,32,239,31,88
1090 DATA 76,121,197,165,1,133,42,165,2,133,43,88,32,57,196,76
1100 DATA 121,197,173,76,232,9,224,141,76,232,41,223,141,76,232,96
1110 DATA 173,77,232,41,2,240,249,96,160,0,230,119,208,2,230,120
1120 DATA 177,119,96,230,1,208,2,230,2,95,165,1,133,136,165,2
1130 DATA 133,137,162,3,160,0,177,136,208,11,32,218,31,202,208,246
1140 DATA 169,255,133,0,96,169,0,133,0,96,198,136,208,2,198,137
1150 DATA 96,160,0,177,1,208,238,200,192,3,144,247,76,208,31,162
1160 DATA 3,32,160,31,169,0,141,65,232,32,146,31,202,208,242,96
```

Listing 4. BASIC loader for PET.

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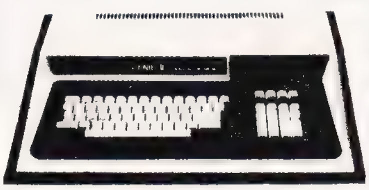
CCC



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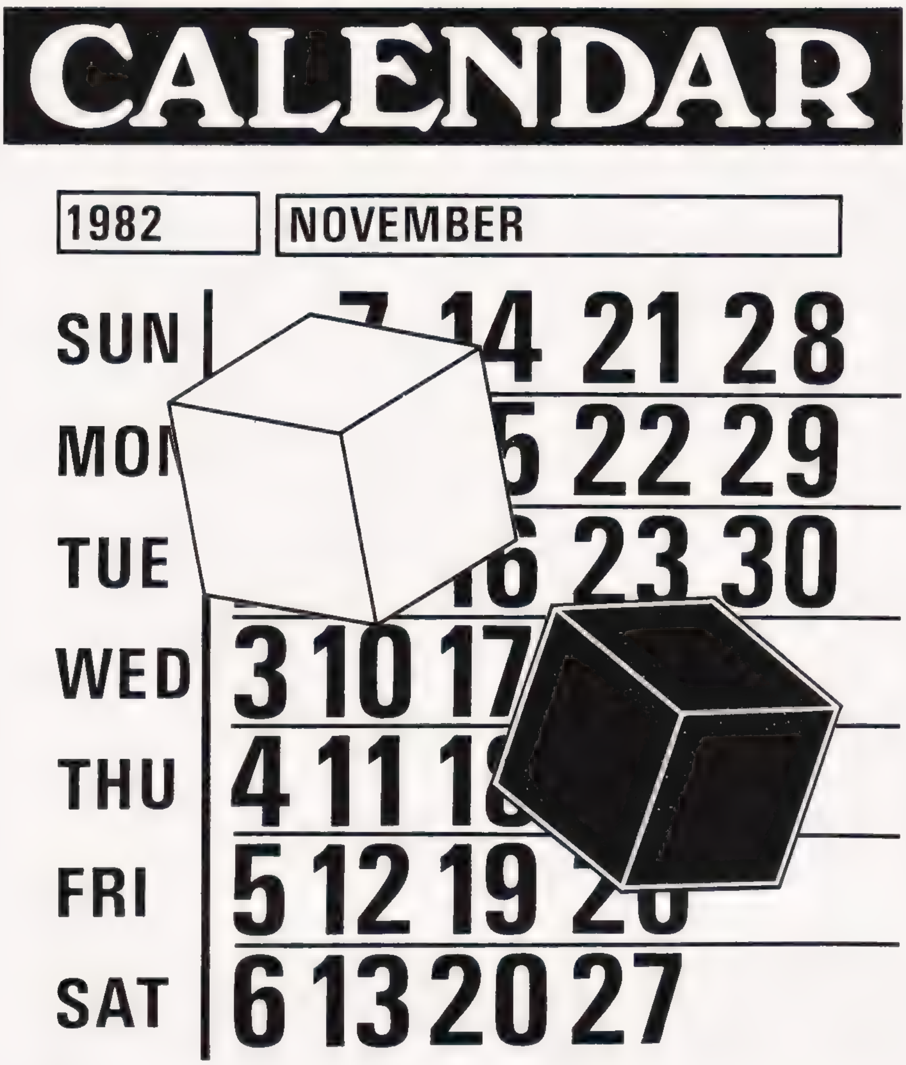
C W Hobbs

PROGRAM DEVELOPMENT

The testing of software is often left to chance, 'it works for the author so it will work for anyone' being a common attitude. But, if you did want to thoroughly test a program how would you set about it?



Anyone who has had their salary calculated by computer and, after a week with a lot of overtime, has received a carefully printed cheque for £0.00, has realised the need for testing computer programs thoroughly.

Testing can, however, be very difficult: during the 10-day flight of Apollo 14, eighteen errors (bugs) were found in the programs controlling the flight and yet we can assume that these programs were very thoroughly tested beforehand. Faced with this level of difficulty, it is not surprising that many home computer enthusiasts hardly test their programs at all. At home this tends to matter less than when controlling a space-craft, but good testing techniques could avoid red faces during the demonstration to an interested grandparent of an 'I calculate the day of the week on which you were born' program when faced with a birthday of 01/12/99.

Testing can also be an interesting pursuit in its own right, especially if you are testing someone else's program. Testing is a very destructive activity and it is much easier to destroy something that you have not built yourself!

TESTING 1, 2, 3

To enable you to estimate your abilities as a tester I would suggest you note down the inputs that you would use to test Listing 1. Before you do so though, it is worth stating the single goal of testing:

To discover as many errors as possible with the minimum number of tests.

Listing 1 accepts a date from the keyboard in the form DD/MM/YY. It interprets it as a date between 1st January, 1900 and 31st December, 1999. It then prints the date out in the form YY.DDD — for example, 01/01/81 becomes 81.001 and 31/12/79 becomes 79.365

To test this program reasonably well without having any details of how the program was written, you should have chosen at least the following inputs:

1. 'Dates' which are not valid:
— day zero (eg 00/01/81)
— month zero (eg 01/00/81)
— month greater than 12 (eg 01/13/81)
— day greater than 31 for a 31-day month (eg 32/12/81)
— day greater than 30 for a 30-day month (eg 31/09/81)
— day greater than 28 for February in a non-leap year (eg 29/02/81)
— day not numeric (eg 1A/01/81)
— month not numeric (eg 01/ 2/81)
— year not numeric (eg 01/01/:;)
— the first slash replaced by another character (eg 01:01/81)
— the second slash replaced by another character (eg 01/01.81)
— less than eight characters typed in (eg 1/1/81)
— more than eight characters typed in (eg 01/01/812)
— 29th February in 1900 (this was not a leap year)
For all of these dates the program must display an error message.

2. Dates which are valid but which are also extremes:
— 01/01/00 (expected output 00.001)

— 31/12/99 (expected output 99.365)
— 31/12/16 (expected output 16.366)

3. Dates which are valid but which are also anomalous:
— 29/02/20 (expected output 20.060)

4. Dates which are valid but which cause anomalous or extreme output:
— 10/01/29 (expected output 29.010, ***not*** 29.01)
— 01/01/09 (expected output 09.001, ***not*** 9.001)
— 10/04/82 (expected output 82.100, ***not*** 82.1)

Note that all of the correct outputs are given in this list. This is particularly important since, if they are not defined before the test is run, then any results can very easily be assumed correct. Note also the four main categories of inputs:

— those which should cause an error message to be printed. The generation of these requires particularly good imagination but this can be assisted by the technique of reading the program specification and underlining the phrases which state a fact. Each of the facts can then be contradicted. For the date program, the relevant phrases are:
— 'accepts a date' (think about invalid dates)
— 'in the form DD/MM/YY' (think about possible format errors)
— 'in the form YY.DDD' (think about likely programming errors)

— those input values which are extremes. If, for example, the program being tested reads two numbers and prints out their average, then if you use as one of the numbers, the maximum number that the computer can handle, the programmer who simply added the two numbers together and divided by two will be caught out. Another common programming error is to allocate buffer areas too short to contain both the maximum length message and an end-of message character. A message of maximum length is thus a useful test case. Do not, however, forget the other extreme: a message containing no characters is also an extreme and is also likely to be successful.

— those input values which, while not extremes, are in some way anomalous. Leap year day is an obvious example for the date program. A good anomaly for a mathematically based program is zero. Since many systems (including Microsoft BASIC) treat a comma as a special character in the input, the use of this character in text input also has a high chance of success if the program specification says that ***all*** characters are to be accepted.

— those input values which produce anomalous or extreme outputs. These inputs are used not only to detect any problem with formatting and printing (as in the date program) but also because an anomalous or extreme output normally causes some anomalous processing or some extreme intermediate results. Either of these is likely to result in a successful test, ie one which finds an error in the program.

THE ULTIMATE QUESTION

Having created a file of test inputs similar to the one given above, an important question to ask is how many of the test cases could be combined. The 'date' 00:00:812, for example, contains several errors and by using it, some time could be saved. The rule here is:

When possible, combine valid test cases but never combine invalid ones.

Thus, the two valid test cases 01/01/00 (extreme date) and 01/01/09 (designed to show that the programmer has forgotten to print the leading zeroes) could safely be combined by omitting the latter test. To combine two invalid dates is, however, unwise since, having discovered one error, the program is likely to stop looking for more. Having thus found the length error in the date 00:00:812, the program would probably never test for the zero day. Any errors in the 'zero day' logic would then never be uncovered.

If we assume that we have created a list of tests similar to the one given above and that these tests have all be unsuccessful (ie have uncovered no errors), can we assume that the program is fully tested? The answer, unfortunately if not unexpectedly, is no. Unless we have recourse to an automated test system (see below) we have, however, come to the end of the line without looking at the program itself. To progress further we need to move from 'Black-Box' testing where only the specification of the program is considered (the program itself being a 'black box') to 'White-Box' testing where we are allowed to examine the program itself. The terms 'White-Box' and 'Black-Box' testing, although widely used, are, in fact, misleading since the method of testing in each case is identical; all that differs is the method by which the test cases are derived.

THE SEARCH CONTINUES . . .

To assist us with our search for further test cases, Listing 1 contains a Microsoft BASIC program which performs the date transformation. It has, however, been written by a careless programmer and, although it passes all of the 'Black-Box' tests listed above, it contains a simple fault.

In every program there are pieces of code which are executed only rarely; the code to handle exceptional errors, for example. A 'Black-Box' test might easily never exercise this code at all. With the aim of uncovering more errors, it is reasonable to try to execute as much of the program as possible. The most obvious approach is to try to produce test-cases which cause every possible path through the program to be exercised. We can quickly see that this is normally impossible by considering Listing 1; there are 11 different paths around the statements 310, 320 and 330, and these statements are only reached if the condition in statement 300 is false. Even a short program, if it contains several loops, can contain many thousands of possible paths.

A second-best criterion for the selection of 'White-Box' test cases is to try to go both ways at each conditional branch instruction at least once. The conditional branches in BASIC are the IF . . . THEN, the ON . . . GOTO and ON . . . GOSUB instructions. Statement 300 in Listing 1 is, for example, a conditional statement and, therefore, we must generate test cases which will cause the branch from there to statement 340 to be taken and also test-cases which will cause it not to be taken. This procedure can be complicated in two ways:

— if the conditional statement is buried in the middle of the program it is not always obvious which input values will, and which will not, cause the branch

— if the conditional branch is not simple; that is, contains AND OR, or ON.

The condition on line 270 of Listing 1:

```
270  IF DD>A(MM) OR DD<1 THEN 60
```

illustrates both of these properties. It is not immediately obvious with which date we should test in order to cause the jump to statement 60 as the condition is a compound one (containing an OR).

SPLITTING THE DIFFERENCE

Compound conditions must be split into the simple conditions from which they are constructed:

```
10  IF A=B OR C=D THEN 100     must be split into:  10a  IF A=B THEN 100
                                                    10b  IF C=D THEN 100
10  ON A GOTO 100,200,300      must be split into:  10a  IF A=1 THEN 100
                                                    10b  IF A=2 THEN 200
                                                    10c  IF A=3 THEN 300
10  IF A=B AND C=D THEN 100    must be split into:  10a  IF NOT A=B THEN 10d
                                                    10b  IF NOT C=D THEN 11
                                                    10c  GOTO 100
                                                    10d  ........
```

This splitting is, of course, only carried out mentally, but since the process is labourious it is better done by computer. There are two types of program available to assist with this work: a 'static analyser' which reads the program under test and deduces what values of input should be used to cause the conditional branches to be properly exercised; and a 'dynamic analyser' which actually watches over the program under test while it runs and reports on how effective the test was.

A simplified Dynamic Analyser can be written in BASIC fairly easily. This program inserts extra BASIC statements into the program under test before each conditional statement. These extra statements increment counters to show whether the simple conditions are true or false. For example, in Listing 1, the conditional statement on line 80 should have the following lines added:

```
78  IF LEN(D$)<>8 THEN C(1)=C(1)+1
79  IF NOT LEN(D$)<>8 THEN
    C(2)=C(2)+1
```

At the end of the program, statements should also be added which print the counters C(1) and C(2) and at the beginning (statements to set them to zero). If both of the counters are greater than zero at the end of the test then we know that statement 80 has been properly tested. Similar extra statements must be inserted for every conditional statement in the program under test. Note that a program to insert these extra statements need not be very complex since for simple IFs, for example, it always uses the two templates:

```
<line number-2> IF <condition> THEN
C(n)=C(n)+1
<line number-1> IF <condition> THEN
C(n+1)=C(n+1)+1
```

adding 2 to n for each IF that it meets and taking the condition, without interpretation, from the IF that it has found. The coding inserted at the beginning to 'zeroise' the counters and at the end to print them is, with the exception of the highest counter number, always the same. The program needs to be slightly more complex to deal with programs with the line numbers too close together and with compound conditions, but not much more so.

THE LAST STRING

None of these efforts are likely to uncover the programming error in Listing 1 but we have one more string to our bow: we can write another date program and compare the outputs of Listing 1 and the other program for a vast number of inputs. The inputs could be generated by a small program (and how would we test that?) which produced every combination of eight characters, presented these to the two date programs and compared the outputs. Almost all of the dates generated would be invalid and ought to be rejected by both of the date programs, but some would be valid and ought to lead to a number in the form YY.DDD being returned to the test program.

Thus, with two date programs (preferably produced by two different people) we can put the approximately 70,000,000,000,000,000 dates into the two programs at the same time and compare the answers. If we assume that although each programmer may make a mistake, both programmers are unlikely to make the same mistake, we can then test the programs completely. At the end of the test we have the additional advantage of having two programs, either of which we can use. The disadvantage lies however, in the fact that even if each program takes only 1 millisecond to check and transform the date, then we will still have to wait about 4.5 million years for the end of the test!

This last technique is often used in areas such as the control of nuclear reactors where the programs are required to make real-time decisions and where cost is less important than safety. This technique would also find the error in Listing 1 and I hope that you will too.

```
10   REM ** THIS PROGRAM ACCEPTS A DATE IN
20   REM ** THE FORM DD/MM/YY AND PRINTS IT
30   REM ** AS YY.DDD
40   DIM A(12)
50   GOTO 70
60   PRINT "THAT DATE IS INVALID"
70   INPUT "WHAT DATE IS FOR CONVERSION";D$
75   REM ** CHECK LENGTH
80   IF LEN(D$)<>8 THEN 60
85   REM ** CHECK SLASHES
90   IF MID$(D$,3,1)<>"/" THEN 60
100  IF MID$(D$,6,1)<>"/" THEN 60
105  REM ** CHECK FOR NUMERICS
110  D$=MID$(D$,1,2)+MID$(D$,4,2)+MID$(D$,7,2)
120  FOR I=1 TO 6
130  X=ASC(MID$(D$,I,1))
140  IF X<48 OR X>57 THEN 60
150  NEXT I
160  DD=VAL(MID$(D$,1,2))
170  MM=VAL(MID$(D$,3,2))
180  YY=VAL(MID$(D$,5,2))
190  REM ** CHECK FOR VALID MONTH
200  IF MM<1 OR MM>12 THEN 60
210  REM ** CHECK FOR VALID DAY
220  RESTORE
230  FOR I=1 TO 12
240  READ A(I)
250  NEXT I
260  IF INT(YY/4)*4=YY AND YY>4 THEN A(2)=29
270  IF DD>A(MM) OR DD<1 THEN 60
280  REM ** ALL VALIDATION COMPLETE
290  REM ** NOW CALCULATE YY.DDD
300  IF MM=1 THEN 340
310  FOR I=1 TO MM-1
320  DD=DD+A(I)
330  NEXT I
340  YY=YY+DD/1000
350  REM ** CALCULATION COMPLETE
360  REM ** NOW PRINT ANSWER
400  E$=STR$(YY+100)+"00"
410  E$=RIGHT$(E$,LEN(E$)-2)
420  E$=LEFT$(E$,6)
430  PRINT "THE ANSWER IS ";E$
440  GOTO 70
1000 DATA 31,28,31,30,31,30,31,31,30,31
1010 DATA 30,31
```

Listing 1.

Don't let its size fool you.

If anything NewBrain is like the Tardis.

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TEXAS INSTRUMENTS

Paul Kriwaczek

MICRO MUSIC

Microcomputers are often claimed to have facilities for producing sounds and musical notes but just what is music? In this two part feature we present the theory behind the generation of computer music and its practice.

Ever since we were at school together, I have had a longstanding argument with a friend of mine, now an influential computer consultant. The disagreement is over the question of whether computers will ever be able to compose music and if so what kind of music it might be. On the surface it seems the kind of argument that could actually be settled, either by applying basic principles or actual experiment, but it turns out to be rather more complicated than one might think.

The trouble is that with music (as with all the arts) it is difficult, if not impossible, to define one's terms of reference; in other words, what exactly does one mean by 'music' or, come to that by 'painting' or by 'poetry'. Is the intention of the artist a factor in the definition, or should one just examine the work itself, irrespective of who created it? (In that case, why is it that a Van Megheren copy of a painting by Vermeer is not accorded the same value as an original?) It seems that one cannot exclude the personality and the historical position of the artist from an analysis of his or her work. But if the arts are a form of communication between a person and an audience, then real music is by definition created by human beings and not by machines. On the other hand, my friend thinks that music is only 'a pretty noise' and so is certainly grist to the computer's mill.

Of course the same argument also applies to the performing arts, and this is where playing rather than composing music comes in. Here, it is easier to accept that things are much more complicated than they may seem at first sight, or at least at first hearing. It is no news that the backing version of a pop record is not of the same value as the original, even if the arrangement is identical, and that a performance by Menuhin is not the same as one by Heifitz, even though the music they are playing is written identically on the score. There are enormous subtleties of expression at work here, which escape the printed notation but are crucial to the listener in his or her appreciation of the piece.

A PINCH OF SALT

So, when an article in the American magazine *Byte* says, with reference to a particular sound generator chip, that "the next great composer will not write for a 72 piece symphony orchestra but for a bank of GI AY-3-8910s", we may take the claim with a generously large pinch of salt.

But that is not to say that computer generated 'music' is of no value. Quite apart from the sound effects which accompany many games, the ability of a micro to repeat faultlessly the same tune over and over, is a godsend for anyone practising a solo instrument who would like a perfect accompanist constantly at hand; or for the songwriter who wants to try out the effect of a complicated chord sequence beyond his or her ability to play at speed on guitar or piano.

It is users like these who will most value the way that the computer's ability to act as a generator of musical sounds has been so greatly developed over the last year or so; today few microcomputers come without some kind of music synthesis ability. The Apple is probably the micro most developed for music generation, but the PET and the TRS-80 also have their musical devotees, while Atari, ATOM, VIC-20, ZX Spectrum, BBC Micro and many others use their ability to emit sounds claiming to be music as strong selling features in their advertising campaigns.

THE FOOD OF LOVE

Like many other computer functions, music systems can be created either in hardware or in software, and as always there are benefits and penalties to either approach; neither one nor the other can be said to be best. To see where the differences lie and which kind of system is most appropriate for a particular need, one has to consider what music actually is.

Music is an ordered arrangement of repetitive waveforms. And that definition ▶

applies whether your favourite sounds are Montiverdi, Mantovani or Madness. The waves detected by the ear are in the form of vibrations in the air, but when these are created by a loudspeaker, the alternating current flowing through the speaker coil is of exactly the same form, as are the electrical waves in the wires running from a microphone which converts the sound energy into electric current or voltage.

At first sight, it seems that in the process of that conversion, some of the information is lost. Not just because real microphones don't have a theoretically ideal frequency response, but because what goes in is a large number of different sound waves from different sources — perhaps two guitars, synthesiser, bass and drums; or even flute, oboe, bassoon, six violins, three 'cellos and a harpsichord — and what comes out at the other end is one single complex wave. In fact, music fed into an oscillograph might generate a pattern similar to Fig 1.

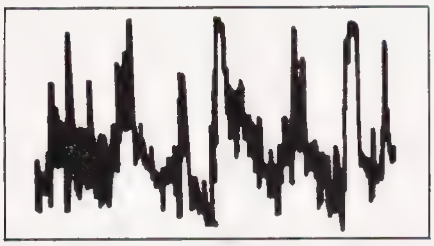


Fig. 1. A loud orchestral passage output from a crystal gramaphone pickup.

This could very well be from the trace of an orchestral symphony or a piano solo. It is very difficult to detect by eye which of the two it is but all the information is still there. Somehow, the ear is able to take this composite wave apart and separate it into individual notes from individual instruments.

In fact, it is not the ear that does the job at all, it is the brain. The ear is just a peripheral — a sort of human equivalent to a computer's analogue to digital converter. One might think that all the brain needs to do is to detect the simple basic waves from which the composite was created in the first place. But its task is rather more difficult than that, since the sounds produced by each individual instrument are themselves complex waves, albeit somewhat simpler than those of the whole orchestra put together. Yet somehow, our brains can extract and reassemble the basic waves which go to make up the sound of a trumpet, say, or a glockenspiel, so that we actually seem to hear them at the same time as, but quite distinctly from, all the rest.

Although we don't understand how the ear and brain combination performs this particular bit of magic, there have been mathematical techniques developed which can analyse a regularly repeating complex wave into a series of simpler components which, when added together, create the original again. Theoretically, there can be a number of different varieties of these simple waves. In practice, only two forms of analysis are often used: Walsh analysis — which breaks the complex wave down into pulse shaped components; and Fourier analysis — which decomposes it into a series of sine waves. Of the two, Fourier analysis has proved to be the more commonly useful, as sine waves are often found in nature and are relatively easy to separate out and then add together again. In principle then, any complex wave can be regarded as the unique result of summing together a number of sine waves of particular frequencies in the correct phase relationship.

THE PERFECT PITCH?

The audible characteristics of a musical sound are pitch, timbre or tone quality, envelope and volume. Of these, the last is simply the amplitude of the vibration and the first two, pitch and timbre, are totally determined by the frequencies and relative amplitudes of the sine waves into which the sound can be analysed. As it happens, the human ear seems to be insensitive to the phase relationships between the components, so for our purposes they can be ignored.

To put the description in less mathematical terms, one can think of every musical sound as being made up of a 'fundamental' pitch and a series of 'harmonics'. In a note with a definite pitch, unlike that from a bell or a drum, the frequencies of the harmonics are all exact multiples of the fundamental. It is the fundamental which tells the ear the pitch of the note, and the harmonics then provide the timbre.

Although timbre is important in giving a note its quality, it is by no means the whole story. A note is a dynamic thing and is constantly changing; in particular, in its volume. Take a piano note for example. When the hammer first strikes the string, the sound builds up very quickly to a maximum peak level from which it falls away again equally quickly. But it does not fall all the way. If the damper is up, the amplitude falls only a little way and then holds at that level, decreasing only slowly. As soon as the damper falls at the end of the note however, the level quickly dies to nothing.
If one follows the amplitude by drawing a line along the tips of the individual wavelets, it forms what is called in mathematics, an envelope. The word, envelope, has been taken over into electronic musical terminology to describe the dynamic variation of volume in the course of playing a note.

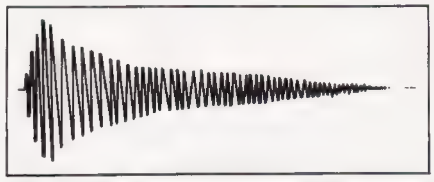


Fig. 2. The gradual decay of a piano note.

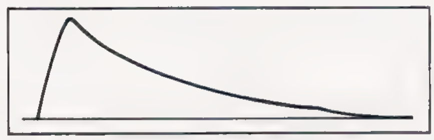


Fig. 3. The envelope of Fig. 2.

The first rise in volume as the sound starts is called the attack and the section during which the note falls away again is called the decay. On many instruments there is then a period during which the note is sustained. On a real instrument, when a note comes to an end, it doesn't simply stop in an instant but dies away to nothing over a measurable period of time. This is called the release. Each of these parts of a note have both a duration and a target amplitude. The duration of the attack is the time the sound takes to build up to its peak, and its target amplitude is the level of that peak. And the same two parameters may be applied to all the other subdivisions of a musical note. In many synthesisers and some microcomputer music systems, the envelope control is divided into these sections and is known by the acronym: ADSR — for Attack, Decay, Sustain, Release.

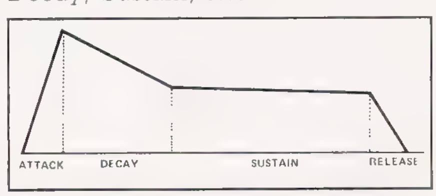


Fig. 4. The schematic breakdown of an envelope illustrating the ADSR.

The envelope of the note is one of the more important factors in determining what the note will sound like. If one plays a tape recording of piano music backwards, the harmonics of the notes are all present in the correct proportions but because the envelope of the notes is reversed, ie a slow attack and a fast decay, the sound is no longer anything like that of a piano. In fact, it sounds much more like a concertina!

ALL CHANGE

But even the envelope is not the whole story, for there are other subtle changes in the notes produced by a real instrument. The proportional relationship between the fundamental and the harmonics is not static; it changes throughout the duration of the note. On a plucked stringed instrument, for example, the proportion of higher harmonics is greater at the beginning of the note than at the end as they have less energy than the lower harmonics, and so they decay more quickly.

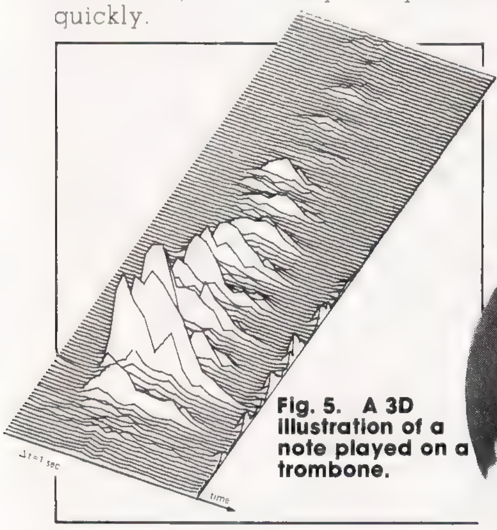


Fig. 5. A 3D illustration of a note played on a trombone.

And the pitch changes too. On some instruments, this is done purposely by players as part of their style. Few saxophonists hit a note dead on pitch; mostly they aim slightly low and slide up. Gypsy-style violin playing is particularly characterised by this sort of device. But sometimes the effect is determined by the physical nature of the instrument. For example, as a guitar string is made to vibrate, its average tension increases slightly thus raising the pitch a fraction. And the louder the note, the greater the average tension and the higher the pitch change.

All of these characteristics of musical sounds are present in the electrical waves running through a speaker coil or a microphone lead. And a computer too can create waveforms like these. Not directly, of course, since a digital computer deals only in binary numbers, but by sending the numbers to a digital to analogue converter which generates a voltage proportional to the numbers sent.

So, looking at the trace in Fig. 1 again, one can see that a computer should be able to create such a waveform by taking all the above factors into account, calculating the voltage value of the appropriate point on the wave every few microseconds and sending the resulting numbers to a digital to analogue converter. And indeed there may be computers which can — but certainly not microcomputers. They are far too slow to do the complex arithmetic necessary for creating the sound shapes in real time. Even large mainframes have the same problem and take a different approach, performing all the calculations first, and storing the results as a music file which is set to the D to A only when it is complete.

But pre-calculation is not a technique available to the microcomputer . . . and for a fairly obvious reason. Take a look at Fig. 1 again. It shows the trace of a minimal moment in the course of a piece of music. Now, there is a well-known rule in sampling theory (Shannon's theorem) which states that the minimum sampling rate must be at least twice the frequency of the highest frequency component in the desired waveform. If the maximum frequency in the resulting music is to be about 15 kHz (somewhere near the limit of the human ear) the sampling frequency must be at least 30 kHz. That means that a minimum of 30,000 samples must be set to the converter every second. For a minute's worth of music, then, we need 1,800,000 samples. If each sample occupies one byte, that constitutes almost the entire address range of a 16-bit microprocessor!

MUSICAL TABLES?

But there is another way one can at least approximate the same effect. The common alternative to real-time arithmetic on a slow micro is the use of look-up tables, and some of the most interesting software music generators, notably those written for the Apple, make considerable use of them.

Suppose that one wishes to create the sound of an instrument, the wave-shape of which is something like Fig. 6. Divide the

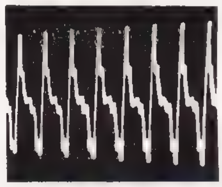
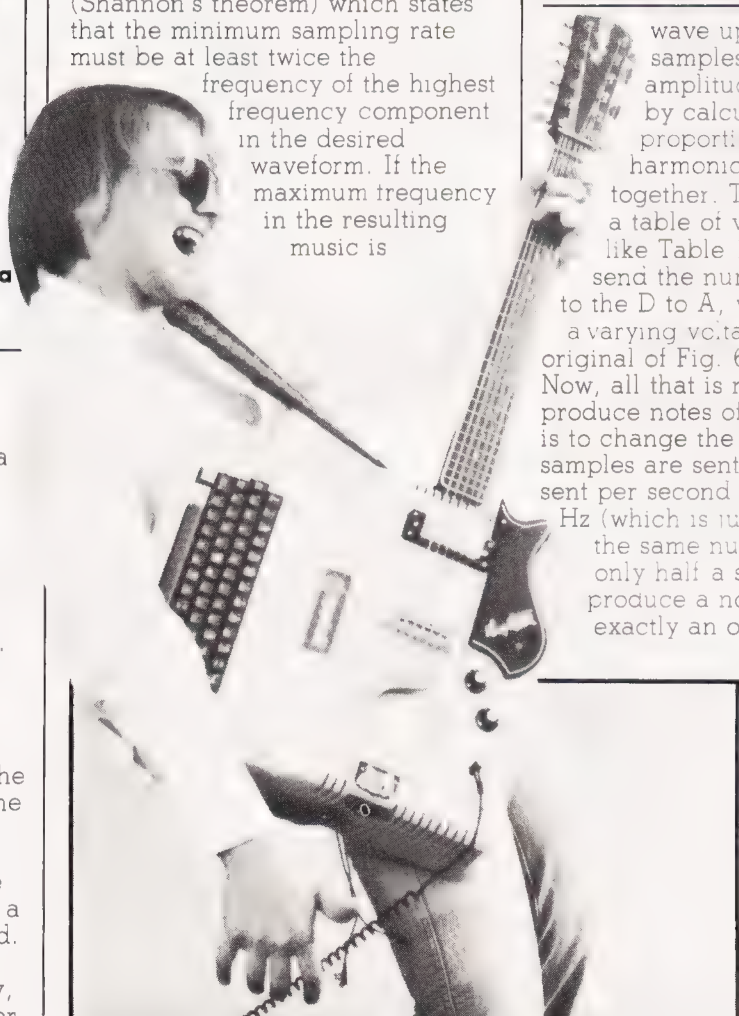


Fig. 6. A single note output from a guitar pickup.

wave up into, say, 256 samples and work out the amplitude at each point by calculating the relative proportions of the different harmonics and add them together. The result will be a table of values something like Table 1 [illegible] then send the numbers in sequence to the D to A, which will produce a varying voltage as close to the original of Fig. 6 as is necessary. Now, all that is necessary to produce notes of different pitches is to change the speed at which the samples are sent. If 32,768 samples sent per second gives a note of 256 Hz (which is just below middle C) the same number sent in only half a second will produce a note exactly an octave higher.



The Apple-style guitar in the photograph was a one-off publicity venture to promote the ALF range of computer controlled music generators.

SAMPLE TABLE

255	254	253	251	248	245	241	236
231	225	219	212	204	196	188	179
171	162	153	143	134	125	117	107
99	91	82	75	67	59	52	46
40	35	29	25	21	17	13	10
8	6	4	3	2	1	0	0
0	0	0	1	1	2	3	4
5	6	6	8	9	9	10	12
13	13	14	15	16	16	17	19
19	20	21	22	22	23	24	25
26	27	28	29	29	31	32	32
34	35	35	36	37	38	39	39
40	41	42	42	42	42	42	42
42	42	42	42	42	41	40	40
39	39	38	37	36	35	35	34
34	33	32	32	32	32	31	31
31	31	31	32	32	32	32	33
34	34	35	35	36	37	38	39
39	40	40	41	42	42	42	42
42	42	42	42	42	42	42	41
40	39	39	38	37	36	35	35
34	32	32	31	29	29	28	27
26	25	24	23	22	22	21	20
19	19	17	16	16	15	14	13
13	12	10	9	9	8	6	6
5	4	3	2	1	1	0	0
0	0	0	1	2	3	4	6
8	10	13	17	21	25	29	35
40	46	52	59	67	75	82	91
99	107	117	125	134	143	153	162
171	179	188	196	204	212	219	225
231	236	241	245	248	251	253	254

Table 1. By dividing a wave up into 256 samples and working out the amplitude of each, you will end up with a table of values as illustrated.

What is more, one can have a number of tables for different sounding instruments, and by looking up appropriate samples from each and adding them together before passing them to the converter, more than one note can be played at the same time. In actual fact, if this technique is used, the sample rate is not varied to produce notes of different pitches as trying to keep different sample rates going at the same time would be exessively complicated. Instead, while the sample rate is kept constant, the step size in the table is varied. For example, stepping to the next but one sample every time amounts to much the same thing as stepping through the whole table at twice the speed; only the precision changes.

Furthermore, if one wished to recreate the change in harmonic structure during the life of a note, as shown in Fig. 5, this can be done by having a number of tables, perhaps 16 of them. Each table would be calculated to produce a slightly different amplitude and harmonic spectrum, and by stepping from one to the next, the note would swell and die away.

There is, of course, a penalty for this increased sophistication. The more calculation necessary to find the right place in the tables from which to fetch the next sample, the longer it takes, and the fewer the samples per second which can be sent to the D to A converter. And bearing in mind the sampling principle mentioned earlier: the slower the sample rate, the lower the maximum frequency content of the final emitted sound. So, some of the commercially available music systems for the Apple, which use this multiple table technique, can provide no more than three voices, none of which can contain harmonics higher than about 8 kHz — not exactly Hi-Fi!

Clearly, however, this method of generating musical sounds has great potential, but potential only to be realised on micros with 16-bit processors running at higher clock speeds than at present, and with peripheral arithmetic chips which can speed up all the necessary calculations.

VOICING OPINIONS

Alternatively, a solution to the difficulty could be achieved by delegating the repetitive calculations to a separate dedicated processor. Its only function would be to cycle continuously, look up samples and send them to the D to A, while occasionally picking up an instruction to change step size or move to another table, from the main computer. Better still, if using today's rather slow chips, there could be a separate processor for each voice.

As far as I know, this idea has not yet been implemented for a micro, although it should not be too difficult a design problem. I envisage the voice consisting of a D to A, fed by a microprocessor with its own RAM — 4K would hold sixteen 256 byte tables (a small area somewhere in its address space which it would share with the main computer so as to allow for communication) and its own control program in ROM allowing for two routines. These two routines would comprise one for cycling the tables, picking up a value, sending it to the D to A and checking for a new command from the host computer every few milliseconds. The other would be a transfer routine which would move bytes to the tables from the common area shared with the main computer, so that the tables could be filled with values calculated by the micro in the normal way. In fact, the ROM could itself be partly replaced by RAM, so that even the control program could be loaded from the main computer. Then, the only thing required would be the byte-transfer routine and a jump to a particular start address on receiving an interrupt signal from the host computer.

The whole circuit would look something like Fig. 7; circuit designers and manufacturers please note!

ENCORE

In next month's instalment, we move away from the theoretical complexities of making music and get down to the practical side of things. As well as delving into the mysteries of constructing a music generator, part two will present you with a full listing of a music composer program complete with the software required to transform your NASCOM into a musical micro. So, as they say, the best is yet to come, music lovers.

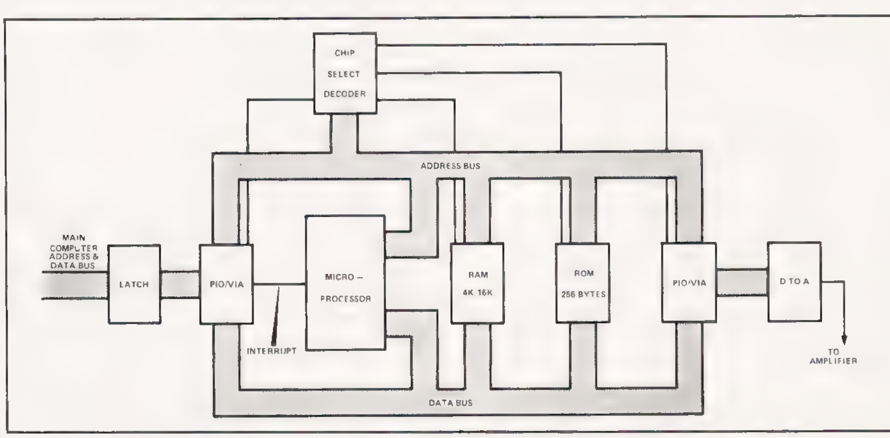


Fig. 7. A possible circuit diagram for a music generator.

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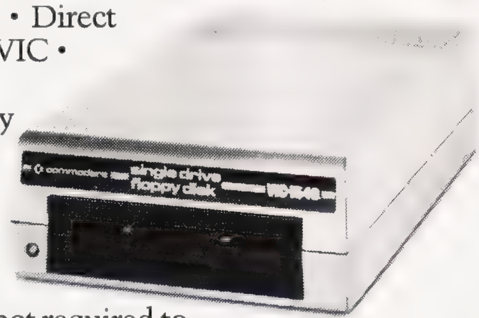

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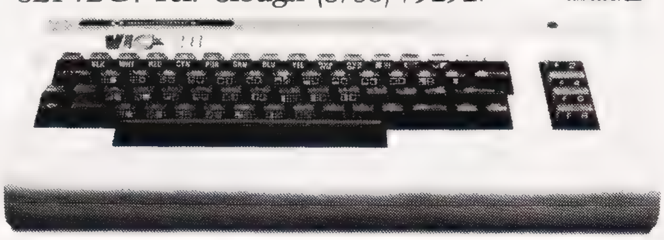

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VCCTO 11/82

Alan Pearmain

TANDY ARRAY DUMP

As an alternative solution to the data compression methods we featured recently why not use arrays to speed up data storage.

Isn't it fun trying to dump a large array from your BASIC program to cassette tape? No? Then this subroutine could be just what you are looking for. It was written to dump numeric arrays quickly, and was inspired by the recent Pools Prediction program (see the October 1981 issue of ***Computing Today***) which I discovered takes some 17-18 minutes to dump and verify the data base. Very tedious indeed; the thought of an error is horrific, and as for keeping a regular back-up copy . . .

The time taken to dump and verify the Pools Prediction data base is due mainly to the TRS-80's habit of restricting the number of bytes which can be written in one operation to 249, with a long header and sync byte being written at the start of each block of data. Machine code clearly offered the best solution, and so I dug out my long-forgotten Editor/Assembler, Zaks manuals and worry beads, and set to work. No doubt those who live and breathe machine code will pour scorn on my efforts, but it does work, and reduces the dump/verify cycle of the above example to just 2½ minutes!

HOW IT WORKS

I should point out here that the subroutine uses the TRS-80's built-in cassette handling routines, and is therefore machine-dependent. The subroutine is embedded in the calling BASIC program by the well-tried method of creating a string variable containing the appropriate ASCII codes, and executing it by means of a USR statement.

The remarks in the assembler listing (Listing 1) should make the operation of the subroutine fairly clear, but the following additional notes may be of help. The addresses of the first and last bytes in the array are POKEd into the string area, as is the command code. The stack pointer which refers to the return address to BASIC is saved (it will be needed if an error return occurs) and the number of bytes to be processed is calculated. A number of swaps between registers via the stack take place around this point — these serve both to save the data which would otherwise be corrupted by cassette routine calls and to allow for the vagaries of certain instructions, especially SBC HL,DE and CPI.

The command code is examined, and appropriate action taken; an error is reported if the code is not valid. The dump, load and verify sections are simple loops, but the CPI instruction in the verify loop is worth further mention. In the other loops, it was necessary to increment HL (the array pointer) and to decrement BC (the byte counter) by specific instructions, but CPI does this for us. It also sets the parity flag to zero if the byte count reaches zero, but unfortunately this cannot be tested in a relative jump and so we must test for zero the hard way.

At the end of normal execution, or if an error occurs, a status value must be reported so that the calling program can take appropriate action. This is done by the four INC DE instructions, which return a value of either 1 — Bad Verify, 2 — Bad Command, 3 — First Address greater than Last, or 4 — No errors found. Finally, the cassette motor is turned off, the original return address is restored and control is passed back to the BASIC interpreter together with the status.

THIS IS BASIC CALLING

The coding required to create and use the subroutine is not too long, and will in many applications be well worthwhile. Listing 2 provides a demonstration BASIC program which generates an integer array containing random values, and can be used to prove just how quickly the subroutine operates.

Ten integer variables are used when preparing the subroutine call. This could, of course, be reduced in practice, but possibly at the expense of extra coding. It should be noted that all variables used must be declared beforehand, preferably during the initialisation section of the program. This is because the declaration of a new simple numeric variable will cause any existing numeric arrays to be moved into a higher memory with disasterous effects on any addresses already established.

The program as shown deals with an integer array; single and double precision arrays can easily be accommodated by changing the offset of the last byte in line 280 from +1 (integer) to +3 (single precision) or +7 (double precision). In practise, several arrays may be dumped in quick succession by repeated calls of the subroutine. Only those variables which relate to the different arrays need be changed, the remainder can be included in a single BASIC subroutine.

A suggested test of the subroutine is after LOADing and RUNning the program, set up a cassette tape for writing and press 1 to start the dump. After a few seconds OK should be displayed. Rewind the tape and press 3 to verify. Again, if all is well, OK will be displayed. If not, check both the coding for finger trouble and also the recorder and tape. Interrupt the program and RUN again. Now try verifying again — you should get BAD VERIFY because the array values were changed. Press 2 to load, having rewound the tape again. If all is well, verify again. You may try pressing another key to check that BAD COMMAND is reported, and by altering the program you can test the FIRST.GT.LAST error check (just swap V1 and V2 in line 280).

MODEST REQUIREMENTS

The Array Dump Subroutine will be valuable in many programs, but if you have to dump only a small number of variables it is probably not worth using. There is, however, a facility built into the BASIC interpreter which, for reasons best known to themselves, Tandy have not made public (as far as I know). Wouldn't it be useful if you could format your cassette output with a USING modifier in the PRINT#−1 statement? Well, you can; the formatting characters appear to function in an identical fashion, but you must put a comma immediately before USING or an error will be reported. This facility works in the old ROM, but I have not had the opportunity to test it on a new ROM machine or on Models 2 and 3.

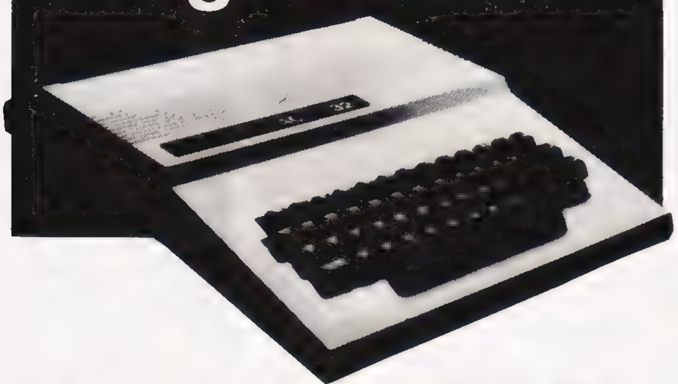
```
11 00 00        DULDVF LD   DE,0     FIRST ARRAY BYTE
21 00 00               LD   HL,0     LAST ARRAY BYTE
01 00 00               LD   BC,0     COMMAND
DD 21 00 00            LD   IX,0     CLEAR IX
DD 39                  ADD  IX,SP    SAVE STACK POINTER
D5                     PUSH DE       SAVE FIRST ADDRESS
AF                     XOR  A        CLEAR CARRY FLAG
ED 52                  SBC  HL,DE    GET NO OF BYTES-1
11 00 00               LD   DE,0     CLEAR DE
38 47                  JR   C,ERR3   ERROR,FIRST>LAST
23                     INC  HL       ADJUST BYTE COUNT
E5                     PUSH HL       SAVE COUNT
CD 12 02               CALL 530      TURN ON CASSETTE
79                     LD   A,C      GET LSB OF COMMAND
FE 01                  CP   01       COMMAND=1?
28 0A                  JR   Z,DUMP   YES - DUMP
FE 02                  CP   02       COMMAND=2?
28 17                  JR   Z,LOAD   YES - LOAD
FE 03                  CP   03       COMMAND=3?
28 24                  JR   Z,VRFY   YES - VERIFY
18 34                  JR   ERR2     ERROR,BAD COMMAND
CD 87 02        DUMP   CALL 647      WRITE HEADER/SYNC
C1                     POP  BC       RESTORE COUNT
E1                     POP  HL       RESTORE 1ST ADDRESS
7E              LOOPD  LD   A,(HL)   GET BYTE FROM ARRAY
CD 64 02               CALL 612      WRITE BYTE
23                     INC  HL       INCREMENT POINTER
0B                     DEC  BC       DECREMENT COUNT
78                     LD   A,B      GET MSB OF COUNT
B1                     OR   C        MERGE LSB
20 F6                  JR   NZ,LOOPD
18 21                  JR   DONE     DO UNTIL COUNT=0
CD 96 02        LOAD   CALL 662      READ HEADER/SYNC
C1                     POP  BC       RESTORE COUNT
E1                     POP  HL       RESTORE 1ST ADDRESS
CD 35 02        LOOPL  CALL 565      READ BYTE
77                     LD   (HL),A   STORE BYTE IN ARRAY
23                     INC  HL       INCREMENT POINTER
0B                     DEC  BC       DECREMENT COUNT
78                     LD   A,B      GET MSB OF COUNT
B1                     OR   C        MERGE LSB
20 F6                  JR   NZ,LOOPL
18 10                  JR   DONE     DO UNTIL COUNT=0
CD 96 02        VRFY   CALL 662      READ HEADER/SYNC
C1                     POP  BC       RESTORE COUNT
E1                     POP  HL       RESTORE 1ST ADDRESS
CD 35 02        LOOPV  CALL 565      READ BYTE
ED A1                  CPI           COMPARE WITH ARRAY
20 07                  JR   NZ,ERR1ERROR,NO MATCH
78                     LD   A,B      GET MSB OF COUNT
B1                     OR   C        MERGE LSB
20 F5                  JR   NZ,LOOPV
13              DONE   INC  DE       OK,STATUS=4
13              ERR3   INC  DE       ERROR,STATUS=3
13              ERR2   INC  DE       ERROR,STATUS=2
13              ERR1   INC  DE       ERROR,STATUS=1
D5                     PUSH DE       SAVE STATUS WORD
CD F8 01               CALL 504      TURN OFF CASSETTE
E1                     POP  HL       RESTORE STATUS WORD
DD F9                  LD   SP,IX    RESTORE RETURN ADDRS
C3 9A 0A               JP   2714     RETURN TO BASIC
```

◀ **Listing 1.**

```
100  CLS:CLEAR 250:DEFSTR A-B:DEFINT C-Z:RANDOM
110  DIM Q(25,25)
120  FOR X=0 TO 25:FOR Y=0 TO 25:Q(X,Y)=RND(32767):NEXT:
     NEXT
130  DATA 17,0,0,33,0,0,1,0,0,221,33,0,0,221,57,213,
     175,237,82
140  DATA 17,0,0,56,71,35,229,205,18,2,121,254,1,40,
     10,254,2,40
150  DATA 23,254,3,40,36,24,52,205,135,2,193,225,126,
     205,100,2
160  DATA 35,11,120,177,32,246,24,33,205,150,2,193,225,
     205,53,2
170  DATA 119,35,11,120,177,32,246,24,16,205,150,2,193,
     225,205
180  DATA 53,2,237,61,32,7,120,177,32,245,19,19,19,19,
     213,205
190  DATA 248,1,225,221,249,195,154,10
195  REM ** BUILD PROGRAM STRING
200  FOR X=1 TO 108:READ Y:B=B+CHR$(Y):NEXT
210  V0=0:V1=0:V2=0:V3=0:V4=0:V5=0:V6=0:V7=0:V8=0:V9=0
220  REM ** MAIN PROGRAM
230  CLS:PRINT "1 = DUMP  2 = LOAD  3 = VERIFY"
240  PRINT "COMMAND: ";
250  A=INKEY$:IF A="" THEN 250 ELSE VC=VAL(A
260  REM ** SET UP SUBROUTINE CALL
270  REM ** GET ADDRESSES OF FIRST AND LAST BYTES OF
     ARRAY
280  V1=VARPTR(Q(0,0)):V2=VARPTR(Q(25,25))+1
290  REM ** GET START ADDRESS OF SUBROUTINE
300  V3=VARPTR(B)+1:V4=V3+1:V5=PEEK(V3)+PEEK(V4)*256
310  REM ** GET LSB AND MSB OF ARRAY ADDRESSES
320  V6=INT(V1/256):V7=V1-256*V6
330  V8=INT(V2/256):V8=V2-256*V7
340  REM ** PUT ADDRESSES INTO SUBROUTINE
350  POKE V5+1,V7:POKE V5+2,V6
360  POKE V5+4,V9:POKE V5+5,V8
370  REM ** PUT COMMAND INTO SUBROUTINE
380  POKE V5+7,VC
390  REM ** LOAD START ADDRESS AND CALL SUBROUTINE
400  POKE 16526,PEEK(V3):POKE 16527,PEEK(V4)
410  V0=USR(V0)
420  REM ** CHECK RESULT
430  IF V0=1 THEN PRINT "BAD VERIFY"
440  IF V0=2 THEN PRINT "BAD COMMAND"
450  IF V0=3 THEN PRINT "FIRST ADDRESS>LAST ADDRESS"
460  IF V0=4 THEN PRINT "OK"
470  FOR X=0 TO 2000:NEXT:GOTO 230
```

Listing 2.

let the DRAGON 32 fire your imagination . . .



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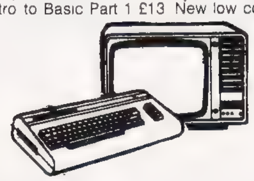

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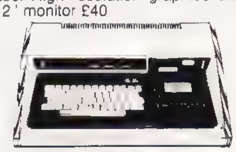

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COMPETITION

Last month we came all over-generous and gave away a ZX Spectrum system together with a ZX Printer and some software. Well, if you weren't lucky enough or if you'd already got a Spectrum, then perhaps you might like to try your hand at this month's competition.

We are offering fifteen sets of the Melbourne House Spectrum Library, three books in all, worth around £23 per set. The titles included are:

Understanding Your Spectrum by Ian Logan

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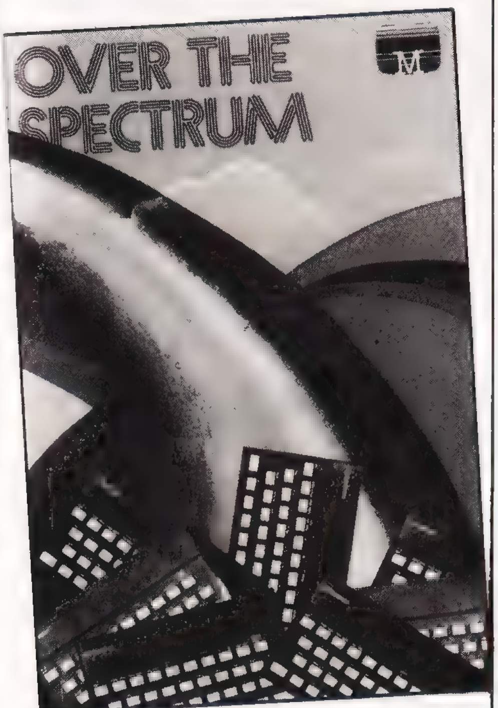

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CT Spectrum Books Competition

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#FILE

From the depths of the darkest recesses of the English countryside our Editor emerges to prove, once again, that questions can be answered!

It's back to the old and trusted formula this month, lots of interesting questions to be answered and information to be generously distributed among the needy. Sadly, this copy is being written before I've had any feedback from the new style of the magazine so your comments on that subject will have to wait until next month. That is, if you have any comments!

First out of the Editorial in-tray this month is a letter concerning that most mystifying of subjects, the mixing of machine code and BASIC:

I wonder if you could help me. I am quite proficient at BASIC programming and I have recently started using 6502 machine code as we have about 10 PETs at college. I am having problems transferring variables between my BASIC programs and the machine code so, in order to help solve this, I wondered if you could tell me the PEEK addresses on a 4106 or 4032 of the Accumulator, X and Y Index Registers, the Processor Status Word, Stack Pointer, the Stack and the Program Counter, assuming that they exist.

As you can possibly see, I am not very proficient at machine code programming yet so, while I'm asking one question, could you also give a brief description of Zero Page Indexed addressing. I also wondered if you could give an opinion of **Programming the PET/CBM**. *How good is it compared to* **The PET Revealed** *and is it really worth the extra £5.*

Well, the young Mr Button (is he a bright one?) certainly wants value for his first class stamp.

As to the first question, the answers are varied, depending upon the competence of the programmer and his or her familiarity of the workings of BASIC. The PET provides two commands which allow BASIC and machine code to be joined together: SYS and USR. The former simply specifies the address at which the machine code program is stored; SYS (826) for example, would jump to the machine code program which starts at location 826. This command is normally used for calling routines which are part of the operating system and require no variables to be transferred — it is also easier to grasp for the beginner. The second function, USR, carries an argument and allows a single-floating point variable to be transferred to and from the routine.

OK, what if you want more than one variable? Well, if you aren't up to actually manipulating the variable storage area, finding the location of the variable you need and reading it into the machine code program, the easiest way is to POKE the value to a protected area of memory — the cassette buffer is a particular favourite — and then load the value from that location in the machine code routine. This is easily done for single integer values up to 255 but requires a little more thought to cater for floating-point values. The really sneaky approach is to POKE the address of the variable rather than its actual value into the buffer. This can be done as an integer as you can find out from BASIC where the variables are stored and then add an offset to point to the actual variable you need

INDEX LINKED

On the subject of Indexed Zero Page addressing the answer is a little more vague. Indeed, it's rather like being given a piece of paper with the number 42 written on it — the answer is obvious but I can't see the need for the question. Indexed addressing is where the eight-bit value stored in the Index Register is added to a fixed value as an offset and is often used in list processing, etc. You can have Zero Page Indexed Addressing but if you are using the Y Index Register the range of facilities is limited: the X Index Register offers all the options. An even more subtle point that has been brought to my notice is that you are only allowed to use an eight-bit address for Zero Page modes but it would be possible to create a nine-bit address if the index and the offset were large enough. The result of this infringement of the rules is not likely to be a problem as it will take the least significant eight bits as the address.

Your question on the two books reveals that you haven't been reading every issue of *Computing Today* . . .tut tut! We reviewed the **Programming the PET/ CBM** volume last year and the only comment I can make is that they are both excellent, the former is aimed more at the first time user and is a guide to programming whereas **The PET Revealed** is a much more casual trip through the inner workings. Both are essential for the serious Commodore user — the price is worth it.

MARKING THE DESK

As the regular readers of system reviews may have noticed, we've gone back to printing the results of each machine's performance on the series of Benchmarks. Now, it's been a long time since we explained just what they all meant so it wasn't really a surprise to receive the following letter:

In this month's magazine you printed an article reviewing the ZX Spectrum. You have printed the results and made a comment on the results found for Benchmark 8 but I can't find any reference to the function of the others. Could you please explain the function of the various tests?

Certainly, Mr Tracy (another good programming name), and this time I'll try to get the list correct unlike the last time I did it!

Taking the tests in order we have Benchmark 1 which performs a simple 1,000 FOR . . .NEXT loop. This tests the speed of a simple single variable loop and, although it provides an answer, it is best used as a comparison with the other results. Benchmark 2 seems to perform exactly the same operation except that it uses an IF . . .THEN structure instead of a FOR . . NEXT loop. This will be slower as the comparison is made each time through the loop whereas in the FOR . . .NEXT loop, there is a single counter being tested rather than a program variable. All our subsequent tests use the IF . . .THEN structure rather than the FOR . . NEXT loop.

Our third test introduces a piece of simple arithmetic and the difference in time between the second and third tests is a direct measure of the speed at which the BASIC does its simple arithmetic. The fourth test looks identical to the third but uses numeric constants instead of variables and should run slightly faster as the retrieval time needed is less for the former. Benchmark 5 introduces a phantom subroutine call. The difference in time between BM4 and BM5 is a direct result of this and, for a well written BASIC should be minimal.

Having added a subroutine call we now incorporate a delay in the subroutine and DIMension an array, although we never actually use it. The extra time taken for this sixth test indicates the efficiency of the BASIC at allocating storage for variables. Benchmark 7 is the last of the universal tests and uses the array we provided in BM6 to store the results of the simple calculation we've been performing since BM3. It takes the longest to run of the general set and is worth testing over a loop of 100 rather than 1,000 to see just how long it's going to take!

Our final Benchmark, BM8, may not run on some systems which only have simple BASICs. It incorporates exponentiation, logarithm and trig functions and can, on poor systems, take an age to run. This is generally tested over 100 loops rather than 1,000 simply because the reviewers like to get to bed before 4.00 am!

A full resume of the tests was printed in October 1980 and it's about time I got round to it again really. The Benchmark programs originated in a magazine called ***Kilobaud*** in the US (it has now changed its name to ***Micro-computing*** for some strange reason).

A WINE TIME

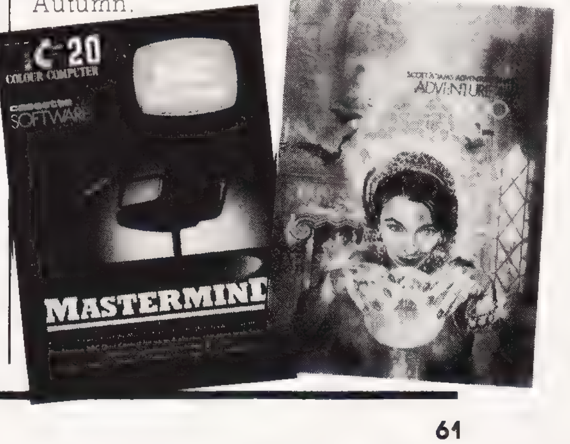
While you may not notice anything different about this month's piece, the original copy was produced under rather interesting conditions. Imagine, if you will, a 16th century cottage and barn standing in the isolated depths of Yorkshire. You might imagine that the excesses of High Technology have yet to creep into these rural areas, but you'd be wrong! Amid the scaffolding, blocks and piles of plasterboard are sited no less than a dozen micros of one sort or another, all vieing for attention. Their owners pace restlessly from one to another, fixing leads, mending disc drives and testing new software. The guest bedroom may well not have glass in its windows (I like fresh air), it may well only have a half plastered wall (no, the wall was half plastered I was totally . . .) but it had its very own Sirius and printer standing ready for me when I arrived! Most useful when you feel a sudden urge to write an article at 3.00 pm or when the cat wakes you at 6.00 am and you can't get back to sleep.

So, I make no apologies for spelling mistakes, they can all be laid at the door of Superspell and Select. Those who thought that Superspell was the latest addition to The Valley take a bow, but you're wrong! No, these two are a matched pair, a word processor and dictionary, that came with the Sirius and I must say that I'm impressed with their performance. As regular readers might know, my feelings towards CP/M are less than favourable and having had the first draft of this month's piece trashed by Wordstar (it was probably the alcohol fumes that did it) I was only too happy to sit down and learn another package. Indeed, finding that there was a second word processor package available has upped the Sirius even further in my opinion — I still hate the noise the discs make and the Speech Synthesis board can be instantly disabled, but as a system to use it's a joy.

VICTOR, VICTORIA?

News has just come in that the VIC-20 has fallen! In price that is, to a new all-time low of £169.99 Effective from the 28th of September the move coincides with the addition of several new High Street outlets and the launch of a multitude of new software packages. Included among the latter are a collection of Adventure-type games and a version of the BBC's famous Mastermind quiz. Commodore are also understood to be launching their own mail-order software operation, early September is currently the favourite date.

Another use of the letters VIC crops up in a new business system called the Victor 9000 from DRG Business Machines, part of the Dickinson Robinson Group. If some of you recognise the beast as being similar to the Sirius then take ten bonus points. It's apparently not just similar, it's identical! ACT don't seem bothered by the competition though, their TV advertising campaign is all set to roll in the Autumn.



MICHAEL ORWIN'S ZX81 CASSETTES

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QUOTES

"Michael Orwin's £5 Cassette Two is very good value. It contains 10 stolid well designed games which work, offer plenty of variety and choice, and are fun."

from the ZX Software review in Your Computer, May '82 issue.

"I had your Invaders-React cassette . . . I was delighted with this first cassette."

P. Rubython, London NW10

"I have been intending to write to you for some days to say how much I enjoy the games on 'Cassette One' which you supplied me with earlier this month." *E. H. London SW4*

" . . .I previously bought your Cassette One and consider it to be good value for money!"

Richard Ross-Langley, Managing Director, Mine of Information Ltd.

CASSETTE 1

(eleven 1k programs)

machine code:
React, Invaders, Phantom aliens, Maze of death, Planet lander, Bouncing letters, Bug splat.
Basic:
IChing, Mastermind, Robots, Basic Hangman.
PLUS Large screen versions of Invaders and Maze of Death, ready for when you get 16k.
Cassette 1 costs £3.80

CASSETTE 2

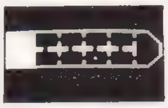
Ten games in Basic for 16k ZX81

Cassette Two contains Reversi, Awari, Laser Bases, Word Mastermind, Rectangles, Crash, Roulette, Pontoon, Penny Shoot and Gun Command.
Cassette 2 costs £5.

CASSETTE 3

8 programs for 16k ZX81

STARSHIP TROJAN



Repair your Starship before disaster strikes. Hazards include asphyxiation, radiation, escaped biological specimens and plunging into a Supernova.

STARTREK This version of the well known space adventure game features variable Klingon mobility, and graphic photo torpedo tracking.
PRINCESS OF KRAAL
An adventure game.
BATTLE Strategy game for 1 to 4 players.
KALABRIASZ World's silliest card game, full of pointless complicated rules.
CUBE Rubik Cube simulator, with lots of functions including 'Backstep'.
SECRET MESSAGES This message coding program is very txlp qexi jf.
MARTIAN CRICKET A simple but addictive game (totally unlike Earth cricket) in machine code. The speed is variable, and its top speed is very fast.
Cassette 3 costs £5.

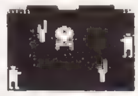
CASSETTE 4

8 games for 16k

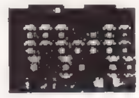
ZX-SCRAMBLE (machine code)

Bomb and shoot your way through the fortified caves.

GUNFIGHT (machine code)



INVADERS (machine code)



FUNGALOIDS (machine code)
GALAXY INVADERS (machine code)
Fleets of swooping and diving alien craft.
SNAKEBITE (machine code)
Eat the snake before it eats you. Variable speed (very fast at top speed)
LIFE (machine code)
A ZX81 version of the well known game.
3D TIC-TAC-TOE (Basic)
Played on a 4×4×4 board, this is a game for the brain. It is very hard to beat the computer at it.
7 of the 8 games are in machine code, because this is much faster than Basic. (Some of these games were previously available from J. Steadman).
Cassette 4 costs £5.
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BBC 6	Expansion bus and tube kit (IC71, 72, 76 + PL11, 12)	6.25
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BBC 55	5 and 6 pin DIN plugs for Serial I/O and RGB input	0.99
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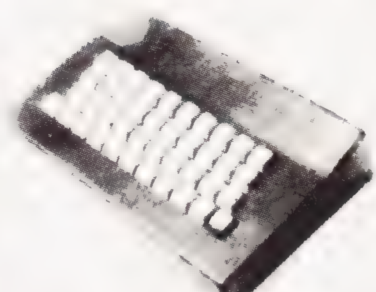

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Paul Aitken

VIEWPOINT

Can schools software really overcome the user barrier?

In 'the good old days', when the only teaching machines in evidence in our classrooms were four foot blackboard pointers that could streak their way around a classroom with the dexterity of a Cruise missile and when each of the children sat there looking like extras for a Hovis commercial, the measure of each child was whether they passed or failed the year's work. Those days are gone, their passing unnoticed by most and regretted by none.

The transformation of education has been spectacular with the rapid deployment of sophisticated educational technology throughout our schools in the sixties and seventies. Indeed, every school in the land is now not only able to print the Copyright Act but in most cases they can give every member of staff a personal photocopy too! The exploitation of overhead projectors, tape/slide programme packs, episcopes and programmed learning laboratories, show the new emphasis that teachers and educational administrators place on visual communication. The modern classroom has been transformed from the drabness of yesterday to emerge as a multi-coloured Alladin's Cave of knowledge, excitement and adventure. Gone is the total reliance on a terminal exam as a judgement of each year's work, replaced instead by a monitoring system which bases its findings on a series of assessments, recorded throughout the year.

From their very first moment in an educational environment, children will be encompassed in a profusion of visual communication; brightly coloured pictures, line diagrams and signs will shine out at them from every wall. For in education, as in most other aspects of our lives, we see the implementation of the adage that one picture is worth a thousand words. And now, through the advent of the microcomputer, each child can have that picture tailored to their own needs, along with those thousand words to expand and develop the computer's graphic output if need be.

It is here that the real transformation in educational methodology lies, as it is possible for the micro to do what no other item of educational technology can do (with the possible exception of an expert teacher) and that is to tailor its output to the individual needs of the child it is communicating with. This is obviously vital when you have to cater for the wide range of abilities which occur in all types of class groupings and where each individual child is developing at different speeds and on different scales.

For it is not just in selecting the appropriate level of subject content that the micro excells itself, it also has the ability to monitor another all important educational parameter: the rate at which the material is presented to each individual child. This rate of presentation is a vital factor in the new and rapidly expanding mixed ability teaching situation. For while there is no evidence to show that the child who requries more time to assimilate the material of knowledge is in any way backward or educationally retarded, there is clear evidence to substantiate the view that the bright child slowed down by others will be educationally disadvantaged.

Following the reaction of a feature we recently published called 'The Teacher's Tale', we are throwing open a page a month for comment and opinion on the micro industry in general. Submissions for this feature should be between 1500 and 2000 words in length and a flat fee of £25 will be paid on publication for any material we use.

Options expressed on this page are those of the author and are not necessarily endorsed by the Editor.

The need to supply the requirements of these two extremes while still catering for the whole spectrum of teaching demands that exist between them, requires the utilisation of technology with the sophistication of the microcomputer.

Let's take a specific example. A program will present to each child the same sentence for an unlimited number of times. On each occasion, it will omit one random letter from the presentation and the child is expected to tell the computer which letter was omitted. Depending on the child's previous answers the computer will vary the speed of presentation. When asked, the micro will give the child a visual assimilation factor — this gives a measure of the child's observation of written material. Once this is known, all future passages can be presented to the child at the optimum rate for that particular child, while further assessments will give an accurate determination of the child's progress or lack of it in this specific field.

This ability to make a scientific measurement of an individual child's progress is becoming of paramount importance especially with the cost of educating a child in a local authority school now well in excess of £1,000 per annum. Parents anxiously view the bleak employment prospects for the children at the end of eleven years of education and are demanding more accurate and specific assessments of their child's progress. The days of the cryptic clue to the progress of the whole year being squeezed along the bottom margin of a report card and then partially obliterated by a rubber stamp signature, went out with adverts for Ovaltine on the sides of tramcars.

Today's parents realise that they are paying for this expensive piper and are demanding more information on the tune that is played. They look for more positive feedback on their child's development, the extent of that development and the rate at which it is being made. No longer are they satisfied with a generalisation of the position with reference to the other children in the class such as is conveyed by 'average' or 'satisfactory'. To meet this demand, schools will have to turn to the micro in all areas of the curriculum, not only to enable them to amass, assess and store the required data, but also to cope with the mammoth task of printing and distributing the individual progress sheets for all children.


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The ZX Spectrum incorporates all the proven features of the ZX81. But its new 16K BASIC ROM dramatically increases your computing power.

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Yet the price of the Spectrum 16K is an amazing £125! Even the popular 48K version costs only £175!

You may decide to begin with the 16K version. If so, you can still return it later for an upgrade. The cost? Around £60.

Ready to use today, easy to expand tomorrow

Your ZX Spectrum comes with a mains adaptor and all the necessary leads to connect to most cassette recorders and TVs (colour or black and white).

Employing Sinclair BASIC (now used in over 500,000 computers worldwide) the ZX Spectrum comes complete with two manuals which together represent a detailed course in BASIC programming. Whether you're a beginner or a competent programmer, you'll find them both of immense help. Depending on your computer experience, you'll quickly be moving into the colourful world of ZX Spectrum professional-level computing.

There's no need to stop there. The ZX Printer – available now – is fully compatible with the ZX Spectrum. And later this year there will be Microdrives for massive amounts of extra on-line storage, plus an RS232 / network interface board.

Key features of the Sinclair ZX Spectrum

- Full colour – 8 colours each for foreground, background and border, plus flashing and brightness-intensity control.
- Sound – BEEP command with variable pitch and duration.
- Massive RAM – 16K or 48K.
- Full-size moving-key keyboard – all keys at normal typewriter pitch, with repeat facility on each key.
- High-resolution – 256 dots horizontally x 192 vertically, each individually addressable for true high-resolution graphics.
- ASCII character set – with upper- and lower-case characters.
- Teletext-compatible – user software can generate 40 characters per line or other settings.
- High speed LOAD & SAVE – 16K in 100 seconds via cassette, with VERIFY & MERGE for programs and separate data files.
- Sinclair 16K extended BASIC – incorporating unique 'one-touch' keyword entry, syntax check, and report codes.

um

RS232/network interface board

This interface, available later this year, will enable you to connect your ZX Spectrum to a whole host of printers, terminals and other computers.

The potential is enormous. And the astonishingly low price of only £20 is possible only because the operating systems are already designed into the ROM.

ZX Spectrum

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The ZX Printer – available now

Designed exclusively for use with the Sinclair ZX range of computers, the printer offers ZX Spectrum owners the full ASCII character set – including lower-case characters and high-resolution graphics.

A special feature is COPY which prints out exactly what is on the whole TV screen without the need for further instructions. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your ZX Spectrum. A roll of paper (65ft long and 4in wide) is supplied, along with full instructions. Further supplies of paper are available in packs of five rolls.

The ZX Microdrive – coming soon

The new Microdrives, designed especially for the ZX Spectrum, are set to change the face of personal computing.

Each Microdrive is capable of holding up to 100K bytes using a single interchangeable microfloppy.

The transfer rate is 16K bytes per second, with average access time of 3.5 seconds. And you'll be able to connect up to 8 ZX Microdrives to your ZX Spectrum.

All the BASIC commands required for the Microdrives are included on the Spectrum.

A remarkable breakthrough at a remarkable price. The Microdrives are available later this year, for around £50.

How to order your ZX Spectrum

BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day. BY FREEPOST – use the no-stamp needed coupon below. You can pay by cheque, postal order, Barclaycard, Access or Trustcard.

EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option, of course. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

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Qty	Item	Code	Item Price £	Total £
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	Sinclair ZX Spectrum – 48K RAM version	101	175.00	
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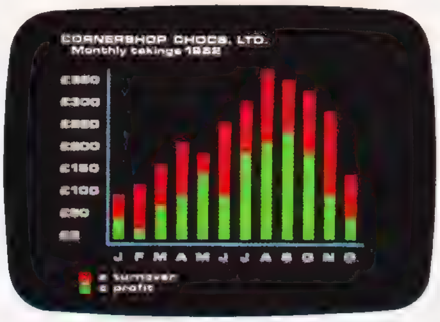
ZX Spectrum software: how good and how soon?

The ZX Spectrum uses an enhanced version of Sinclair BASIC, fast becoming a world standard, and unlikely to be superseded. Unique features, such as one-touch keyword entry and syntax check and report, are increasingly attracting software originators.

Building the software library is already far advanced, and a complete catalogue will be available in the next few months. Subjects will include sophisticated games, education, 'housekeeping', and business management. The more complex packages can, of course, be used to their best advantage with the full 48K RAM version of the ZX Spectrum.

The Sinclair ZX Spectrum can handle sophisticated games programs with high-resolution colour graphics and sound.

This major advance in computer technology maintains Britain's world-beating position in the field of personal computers.



A range of business software will soon be available, covering both specific applications (eg stock-control and payroll) and general business management systems (eg matrix models).

This second generation of Sinclair personal computers demonstrates continuing commitment. Advanced technology made the ZX80/81 family a price breakthrough: advanced technology makes the ZX Spectrum a breakthrough in price and performance.

Elegant, effective, unique—the ZX Spectrum design.

'Less than half the price of its nearest competitor – and more powerful.'

'These two pictures show how it's done. On the right is the PCB from the BBC Model A Microcomputer. On the left is the PCB from the ZX Spectrum.

'It's obvious at a glance that the design of the Spectrum is more elegant. What may not be so obvious is that it also provides more power.

'The ZX Spectrum has more usable RAM, and higher maximum RAM.

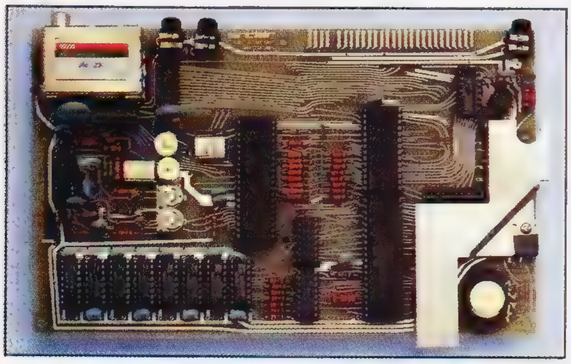
'It offers twice as many colours on the screen at any one time, plus a colour brightness control. It also offers user-definable graphics.

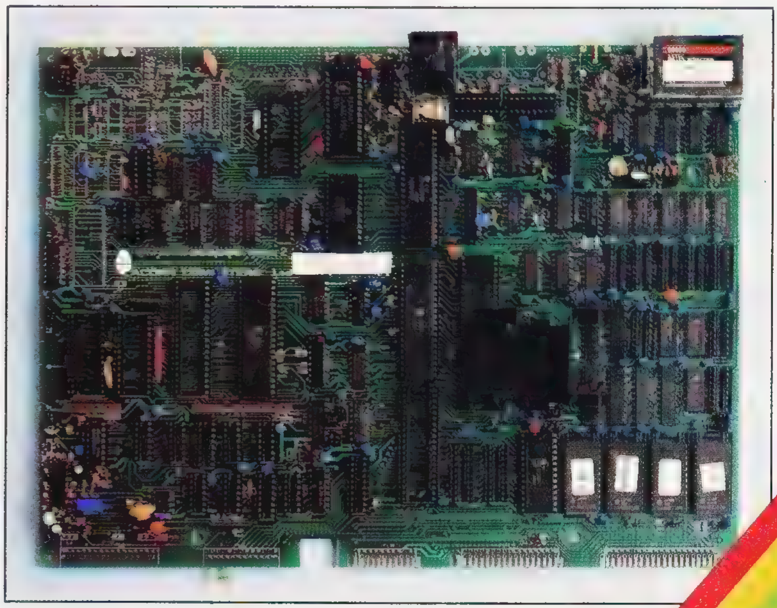
'It has data transfer rate 25% faster, supported by a VERIFY facility.

'And it employs a dialect of BASIC (Sinclair BASIC) already in use in over 500,000 computers worldwide.

'We believe the BBC make the world's best TV programmes – and that Sinclair make the world's best computers!'

– Clive Sinclair.





Above left: internal layout of Sinclair ZX Spectrum.

Right: Internal layout of BBC Micro Model A.

The illustrations are to the same scale, and demonstrate the rate of advance in microcomputer design. The ZX Spectrum uses just 14 chips to provide more power and more user-available RAM.

sinclair ZX Spectrum

Pieter Hintjens

VIC EDITOR

The problem with processing text on the VIC-20 is that the screen is rather small. No problem, just make it bigger!

The VIC-20 is a nice little computer: colour, sound and (almost) high resolution graphics at a reasonable cost. Only one problem, right? The display.

It's when you try to cram a decent amount of information into a 22 by 23 screen that you wish there was some way of easily getting a larger screen. Well, there is. In fact, you can alter the configuration of the screen by simple POKEs to give any practical size up to 26 columns and 32 rows.

The screen is controlled by registers in the VIC chip. There are 16 registers which also control the colour, sound and games capabilities of the VIC.

If we call the first VIC register (at 36864) 'VIC' — a tradition begun by ones older and wiser than myself — then the registers that we are interested in are VIC, VIC + 1, VIC + 2 and VIC + 3. These registers control the screen's shape, size, location on the TV screen and the location of the screen RAM in memory.

Let's make some definitions:

VIC = 36864
HP = horizontal screen position on the TV screen (9 to 20)
VP = vertical screen position (10 to 40)
VC = number of video columns (1 to 33)
VR = number of video rows (1 to 27)

The figures in brackets are the practical limits for each value.

Choose some values and try them with:

```
POKE VIC,HP
POKE VIC+1,VP
POKE VIC+2,PEEK(VIC+2)AND 128 OR VC
POKE VIC+3,PEEK(VIC+3)AND 129 OR VR*2
```

Now try a few other values until you get the hang of what's going on.

If you experiment a little more, you may discover that:
— the cursor is totally befuddled with VC not equal to 22.
— only the first 506 screen locations can be printed to and only the first 512 can be POKEd to.
— 'clr' only works on the first 506 locations.

THE OUTER LIMITS

The fact that we only have 512 bytes of screen RAM available imposes a limit on the screen dimensions of 22 by 23, 26 by 19 or thereabouts. As we want a larger screen (26 by 32) we have to find the room from somewhere.

A useful source of extra RAM is the user's 3.5K. You lose a little (512 bytes) of your program space, but look what you gain. To move the screen down by 512 bytes, we clear bit 7 of VIC + 2:

```
POKE VIC+2,PEEK(VIC+2) AND NOT 128
```

We must protect our new screen by lowering the top-of-memory pointers so that BASIC can't get at it:

```
POKE 56,27:POKE 52,27
```

We can now define the screen and colour addresses for our new screen:

```
SC=7168:REM ** 7680-512
CO=37888:REM ** 38400-512
```

As the VIC's operating system doesn't know of our scheming, we have to tell it where the new screen is — you wouldn't want to miss any error messages, would you? The statement:

```
POKE 648,SC/256:REM ** 648 STORES MSB OF SCREEN ADDRESS
```

stores the MSB of the new address.

We now have our big screen, ideal for games and any applications where we want to display a lot of information.

The following program is a simple text editor in BASIC and machine code that allows you to:
— write to the screen using the cursor keys, Home, clr, Return, delete, reverse on and reverse off.
— SAVE a screenful to tape by ▶

pressing f1.

— LOAD a screenful of tape by pressing f3. (Note that as the messages PRESS PLAY ON TAPE and PRESS PLAY AND RECORD ON TAPE are suppressed to avoid messing up the screen, you will have to realise what's going on. The cursor will vanish when VIC-ED is waiting for you to press the appropriate keys on the tape recorder.)

— get a printout of the screen on a VIC printer by pressing f5.

THREE IN ONE

The program uses three machine code routines: to save, to load and to clear the screen. The 'clear' routine is necessary because VIC can only clear the first 506 bytes of the screen. Using machine code to store the screen on tape means that we can save it in binary which is about 20 times faster than a normal data save.

The machine code is loaded into a 256 byte block of RAM just below the screen address by reading values from the data statements at the end of the program. The entry points defined in the program for the routines are: CL for 'clear', SV for 'save' and LD for 'load'. Thus, the statement SYS CL will clear the screen.

When you have typed the program, first check very carefully for mistakes in your copying, then SAVE it *before* running — machine code has a nasty habit of killing itself.

When it runs correctly, you will find that for a few moments the screen is full of rubbish — this should vanish as soon as the program loads the machine code and clears the screen. If there are any glitches at this point, look for errors in the machine code.

The program will run on a 3.5K or 6.5K VIC with any practical screen sizes and will fit into the basic VIC if you remove some of the REMs. It *won't* run on a 16K machine. It's all to do with the shifting screen and RAM conflicting — blame Commodore, not me! My advice is to remove the expansion RAM pack and 'downgrade' your VIC.

References: **The VIC Programmers Reference Manual** — Commodore and **VIC Revealed** — Nick Hampshire

```
** VIC-ED BY P.HINTJENS **

VIC-ED IS A SCREEN EDITOR
FOR THE COMMODORE VIC-20 -
IT GIVES THE USER A 26*32
SCREEN AND VARIOUS CURSOR
FUNCTIONS.

VIC-ED ALLOWS THE USER TO
SAVE SCREENS OF TEXT TO A
TAPE IN BINARY. AN AVERAGE
SAVE TAKES ABOUT 40 SECS.

THE USER CAN ALSO MAKE A
HARD COPY OF THE SCREEN IF
A VICPRINTER IS AROUND.

THE FUNCTION KEYS USED ARE

F1 SAVE-TO-TAPE
F3 LOAD-FROM-TAPE
F5 PRINT THE SCREEN

▼▼▼▼▼▼▼▼▼▼▼▼▼▼▼
───────────────────────────

THE PROGRAM DEMONSTRATES
WHAT CAN BE DONE AND ISN'T
AN END IN ITSELF.  IT WILL
LEND ITSELF TO SOME USEFUL
EXPANSION.
```

Program Listing

```
100  VIC=36864
110  VC=26:REM ** COLS
120  VR=32:REM ** ROWS
130  DEF FNA(I)=I-128*(I<128):REM ** INV CHAR FOR CURSOR
140  DEF FNB(I)=I+128*(I>127)
150  POKE VIC,9:REM ** XPOS OF SCREEN
160  POKE VIC+1,18:REM ** YPOS OF SCREEN
170  POKE VIC+2,PEEK(VIC+2) AND 128 OR VC
180  POKE VIC+3,PEEK(VIC+3) AND 129 OR VR*2
190  REM ** MOVE SCREEN DOWN BY 512 BYTES
200  POKE 36866,PEEK(36866) AND NOT 128
210  REM ** DEFINE SCREEN AND COLOUR RAM ADDRESSES
220  SC=7168:CO=37888
230  POKE 648,28:REM ** TELL VIC WHERE SCREEN IS
240  MC=SC-256:REM ** MACHINE CODE START
250  CL=MC:REM ** START OF CLEAR CODE
260  SV=MC+35:REM ** START OF SAVE CODE
270  LD=MC+66:REM ** START OF LOAD CODE
280  POKE 56,27:POKE 52,27:REM ** PROTECT SCREEN FROM
     BASIC BY LOWERING TOP OF MEMORY
290  REM ** LOAD CODE FROM DATA STATEMENTS INTO MC+I
300  FOR I=0 TO 86:READ A:POKE MC+I,A:NEXT
310  SYS MC:REM ** CLEAR SCREEN
320  P=SC:REM ** TOP LEFT
330  RV=0:REM ** REVERSE CHARACTER FLAG
340  REM ** BLINK CURSOR UNTIL A KEY IS HIT
350  POKE P,FNA(PEEK(P)):FOR I=1 TO 40
360  IF PEEK(198)<>0 THEN POKE P,FNB(PEEK(P)):GOTO 390
370  NEXT:POKE P,FNB(PEEK(P)):FOR I=1 TO 40:
     IF PEEK(198)<>0 THEN 390
380  NEXT:GOTO 350
390  A$="":GET A$
400  REM ** CLEAR SCREEN
410  IF A$="[CLS]" THEN SYS CL:P=SC:GOTO 350
420  REM ** HOME CURSOR
430  IF A$="[HOM]" THEN P=SC:GOTO 350
440  REM ** REVERSE ON
450  IF A$="[REV]" THEN RV=1:GOTO 350
460  REM ** REVERSE OFF
470  IF A$="[OFF]" THEN RV=0:GOTO 350
480  REM ** CURSOR KEYS
490  IF A$="[CD]" THEN P=P+VC
500  IF A$="[CU]" THEN P=P-VC
510  IF A$="[CR]" THEN P=P+1
520  IF A$="[CL]" THEN P=P-1
530  REM ** RETURN
540  IF A$=CHR$(13) THEN P=SC+VC+VC*INT((P-SC)/VC)
550  REM ** DELETE
560  IF A$=CHR$(20) THEN POKE P,32:P=P-1
570  IF P<SC THEN P=P+(26*32)
580  IF P>=SC+(26*32) THEN P=P-(26*32)
590  IF A$="[CD]" OR A$="[CU]" OR A$="[CR]" OR A$="[CL]"
     THEN 350
600  IF A$=CHR$(20) OR A$=CHR$(13) THEN 350
610  IF A$="[F1]" THEN GOSUB 840:GOTO 350:REM ** F1
     SAVES TO TAPE
620  IF A$="[F3]" THEN GOSUB 850:REM ** F3 LOADS FROM
     TAPE
630  IF A$="[F5]" THEN GOSUB 730:GOTO 350:REM ** F5
     PRINTS SCREEN
640  REM ** GET SCREEN CODE FROM ASCII INPUT
650  A=ASC(A$):IF A>31 AND A<64 THEN GOTO 700
660  IF A>63 AND A<96 OR A>160 AND A<192 THEN A=A-64:
     GOTO 700
670  IF A=255 THEN A=94:GOTO 700
680  IF A>191 AND A<224 THEN A=A-128:GOTO 700
690  GOTO 350:REM ** UNPRINTABLE
700  IF RV=1 THEN A=FNA(A):REM ** REVERSE FLAG ON
710  POKE P,A:IF P<SC+VR*VC-1 THEN P=P+1
720  GOTO 350:REM ** NEXT CHARACTER
730  REM ** SCREEN COPY
740  A$=CHR$(145):IF (PEEK(36869) AND 2)=2 THEN
     A$=CHR$(17)
750  OPEN 4,4:IF A$=CHR$(17) THEN CLOSE 4:OPEN 4,4,7
760  PRINT#4:A=SC-VC:FOR B=0 TO VR-1:B$=A$:A=A+VC:
     FOR C=A TO A+VC-1
770  D=PEEK(C):IF D>128 THEN D=D-128:RV=1:B$=B$+CHR$(18)
780  IF D<32 THEN D=D+64:GOTO 820
790  IF (D>31) AND (D<64) THEN 820
800  IF (D>63) AND (D<96) THEN D=D+32:GOTO 820
810  IF (D>95) AND (D<128) THEN D=D+64
820  B$=B$+CHR$(D):IF RV=1 THEN B$=B$+CHR$(146):RV=0
830  NEXT:PRINT#4,B$:NEXT:PRINT#4:CLOSE 4:RETURN
840  POKE 648,30:PRINT "[HOM][17 CD]":SYS SV:
     POKE 648,28:RETURN
850  POKE 648,30:PRINT "[HOM][15 CD]":SYS LD:
     POKE 648,28:RETURN
860  REM ** DATA FOR MACHINE CODE ROUTINES
870  REM ** STARTING AT CL,SV AND LD
880  DATA 162,0,169,32,157,0,28,157,0,29
890  DATA 157,0,30,157,0,31,169,0,157,0
900  DATA 148,157,0,149,157,0,150,157,0
910  DATA 151,232,208,225,96,234,162,1
920  DATA 160,255,32,186,255
930  DATA 169,0,32,189,255,169,28,133,2,169,0,133,1
940  DATA 169,1,162,64,160,31,216,255,96,234
950  DATA 162,1,160,255,32,186,255,169,0,32,189
960  DATA 255,162,255,160,255,32,213,255,96,234
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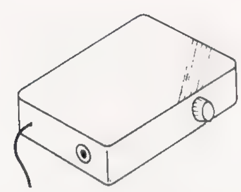

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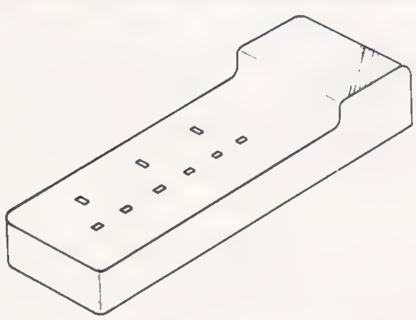

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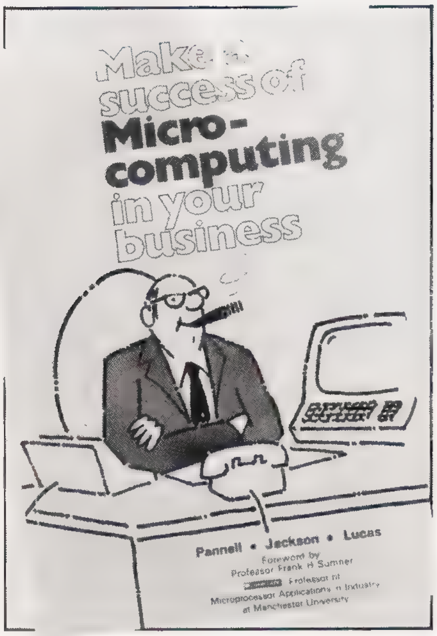
BOOK PAGE

A good read for the businessperson. Well, some of them are and some of them aren't!



The advent of the microcomputer is widely expected to revolutionise the world of small business. Exactly how this is going to be brought about, however, is not really clear. Obviously, one step necessary to participate in the millenia is to purchase your own micro but unless you have a clear idea of what you want to do with it and how this can be put into practice, you may find you have a white elephant on your hands.

The first step, therefore, is to discover what a micro could do for you and choose the right set-up for your purposes. Reading *Computing Today* helps with this, of course — in fact, it's essential if you want to keep abreast of developments. Books can give you general advice about what type of machine to choose but any specific information they contain will date rapidly. So, only by reading the current periodicals can you keep up with the rapidly changing market and find out about the latest products. However, although it's vital to read all the adverts, it is also very confusing as each manufacturer and dealer is trying to persuade you of the merits of their own products. If you are a businessperson contemplating the purchase of a microcomputer, you also need some advice that will enable *you* to take a critical look at the possible ways a micro might help your business and to consider the specifications of a system suited to your needs.

I've looked at three books which set out to help the businessperson select a micro. The one with the most relevant title is **Choosing and Using a Business Microcomputer** published by Gower. This is a hardback book with a very attractive presentation — it contains lots of photographs and diagrams and even some lighthearted cartoons. Its first chapter assumes no prior knowledge of computers and presents a clear and concise introduction conveying the meaning of lots of otherwise mystifying jargon — keywords are in a bold typeface which highlights their usage. The next chapter, Planning for a microcomputer, is the one which raises the issues that the prospective buyer needs to consider. Included in the list are staff reaction and training, what happens when the computer breaks down (a short section which you would be wise to read very carefully) and security (including some salutory warnings on the handling of floppy discs). The text then goes on to discuss choosing the software before choosing the system. For the businessperson, this is the right order in which to consider the matter.

The book also shatters some of the pervasive myths that abound, pointing out that the cheapest available micros do not, on their own, constitute an adequate business system and that 'good software may take eighteen months to write and perfect'. The final chapter presents four case studies depicting the different experiences of four computer users in business situations.

Appendix I is a checklist of questions to ask in order to determine your need for a micro and Appendix II is a survey of the machines which were the most popular business micros in December 1980 (which rather demonstrates that books are not a good source of up to the minute data!). Commodore head this list, which is perfectly fair on the basis of their popularity. What is more disturbing, however, is the way that the PET and PET-related products feature in both photographs and examples throughout — this in a book which declares no special interests.

The **Business System Buyer's Guide** starts with some rather hair-raising case studies presented as cautionary tales. The next chapter encourages you to write your own 'specification' of what you need your microcomputer system to do and gives guidelines for going about that task. Chapter three introduces all the aspects of a comuter system in a straightforward but technically-oriented way. The checklist at the end of Chapter four, How to Buy a Computer, is at a much more minute level of detail than its corresponding part, **Choosing and Using a Business Microcomputer**. The main drawback with this book, apparent in this and the chapters on after-sales support and actual products, is that the information contained relates to the USA. In particular, this means that the appendix, which gives a list of addresses, is of no real value to prospective buyers in this country.

The third book is **Making a Success of Microcomputing in your Business**. This covers the ground in a rather different way, devoting space to some of the technicalities of data processing in addition to a discussion of software and hardware. It includes a short chapter on computer bureaux but does not go into details of any specific microcomputer systems. A central chapter in this book, entitled Selecting the system and supplier, gives the advice to choose a supplier who will 'take overall responsibility for all aspects' — a tall order indeed! This book is aimed at managers of small and medium sized concerns to judge from the case studies included in the appendix, and is a straightforward, readable introduction containing unbiased advice.

Just to complete my coverage of the business spectrum, I'll quickly mention two books which will be of interest to those in larger organisations. **The Directors Guide to Computing 1981** from the Institute of Directors is a pamphlet containing a selection of short articles by respected authorities. It aims 'to give directors the guidance they need to evaluate the many options for computerising their businesses' and is packed with debate on topics as wide ranging as the latest developments in peripherals to computer security.

Among its other aims, **Managing with Computers** has been written to enable managers 'to dismiss, knowledgeably, any spurious claims about the special nature of computing or computer staff'. It makes only a few passing references to micros and concentrates on topics such as 'exercise of user power' and computers and industrial relations'.

What if you've already committed yourself and installed your micro? You may be wanting sources of extra software to run on your system to extend the range of its capabilities. The next four titles I've been looking at are all collections of programs intended to be useful in small business settings.

Simple BASIC Programs for Business Applications opens with 50 pages of 'Primer' which is intended to teach enough about BASIC to enable users to modify the programs to suit their own needs. This presents the rudiments of BASIC clearly, if at a rather fast pace, and has been written using the TRS-80 as the model. However, the beginning of the next section assumes that the programs will be run from a terminal with a time-sharing mainframe. Luckily, from the point of view of micro owners, this only occupies a couple of pages, but this assumption — and the fact that the programs are only available on magnetic tapes rather than disc or cassette — tends to colour the whole volume. As for the programs, the vast majority of them are statistical — starting with means and moving averages and progressing to non-parametric stats, regression and analysis of variance. Some of the latter programs are actually far from simple, either to use or to understand the results of!

There are also a lot of very short programs for financial calculations such as loan repayments and compound interest. Other programs that I would expect to find in a book with this title — stock control, ledger balancing or payroll management — are notable by their complete absence. Altogether, this book is not as useful to the businessperson with a micro as its title would suggest.

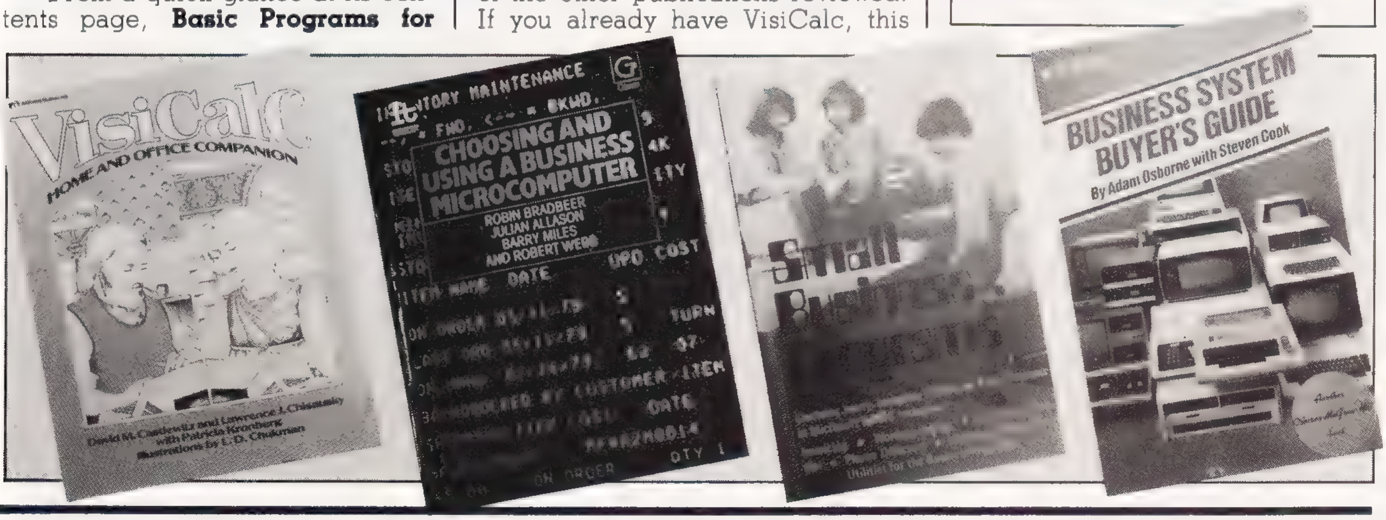
From a quick glance at its contents page, **Basic Programs for Home Financial Management** seems as though it would be equally useful in the office as in the home. As well as programs to do with personal finances — chequebook reconciliation, income tax estimator and credit card organizer — it also has titles such as retirement fund, stock plotter and rental bookkeeping. Unfortunately, closer inspection reveals that very few of the programs are of any practical value. They are mostly too short to achieve much and some, such as the income tax program mentioned above, are specific only to the USA..

The previous two titles are large format books and are fairly weighty tomes. By contrast, **Small Business Programs** is small and light. However, its dollar price is actually in excess of both of them. It contains 32 programs all written for micros (they are also available on cassette): seven for the PET; 10 for the TRS-80; four for the Sharp MZ-80K; and 11 for the Superboard. Although the programs are all short, some of them are intended to do very useful things. There is a payroll program, one for an inventory and a break-even analysis. Also included is a rudimentary word processor. There is little explanation of the programs — in some cases none at all — so if you try to convert them to run on another machine and they do not work first time round, it may be difficult to discover why.

The **VisiCalc Home and Office Companion** is a book containing 50 'models' arranged in seven sections: loans and investments; general business; inventory control; advertising and sales; personnel and departments; personal finance; and household aids. These routines can only be run with the VisiCalc program — in other words, you have to invest £200 in software before you can use the book! There is, however, a world of difference in the results which you can obtain with this combination over those you'll get from trying to rely on any of the other publications reviewed. If you already have VisiCalc, this book is recommended as being likely to help you use it more fully. If you have not, you might like to look at the model runs presented in the book to help you decide if VisiCalc could actually be useful to you.

The books included in this month's selection were:

Choosing and Using a Business Microcomputer by Robin Bradbeer, Julian Allason, Barry Miles and Robert Webb, published by Gower (1982), 172 pages, £12.50.
Business System Buyer's Guide by Adam Osborne with Steven Cook, published by Osborne/McGraw-Hill (1981), 165 pages, £7.95.
Making a Success of Microcomputing in your Business by Pannell, Jackson and Lewis, published by Enterprise Books (1981), 120 pages, £4.95.
The Directors Guide to Computing 1981 published by the Institute of Directors (1981), 95 pages, £1.95.
Managing with Computers by Terry Rowan, published by Pan (1982), 299 pages, £2.50.
Simple BASIC Programs for Business Applications by J R F Alonso, published by Spectrum Books (1981), 297 pages, $12.95/ £9.70.
Basic Programs for Home Financial Management by W B Goldsmith, published by Spectrum Books (1981), 314 pages, $12.95/ £9.70.
Small Business Programs by S Roberts, published by Elcomp (1980), 117 pages, $14.90.
VisiCalc Home and Office Companion by David M Castlewitz and Lawrence J Chisausky with Patricia Kronberg, published by Osborne/ McGraw-Hill (1982), 181 pages, £11.60.



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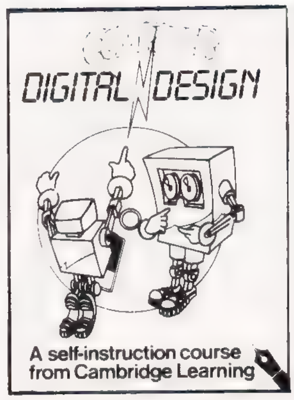

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PRINTOUT

Dear Sir,

One of the first problems facing learners is how to choose between the ever-increasing number of magazines and newsletters on the market — I assume the average person can't afford **all** of them!

Having a BBC micro, I've decided to subscribe to Beebug and Acorn User regularly and then buy odd copies from the weeklies and monthlies, basing my choice on whether they contain an article or useful advertisement about the BBC machine. This must be fairly common practice, judging from the number of people rapidly leafing through the contents of the computer magazine shelves in my local W H Smiths!

It would be a great help to all of us if magazines like yours would, as standard practice, indicate on your contents page, to which micro each article/feature refers, or put 'General' if it is a piece of general interest. I know you often do this (eg Casio Convoy) but not always.

Another problem then develops — how to store and retrieve all those useful bits of information and advice that I might want to refer to. I hope to have a disc drive one day and am now trying to plan a filing system — not of the items themselves, but to their location on my bookshelf. For example, suppose I want to be able to call up SOFTWARE, then GAMES or NOTGAMES then get 'PUBLISHER ..... X, CT AUG 82 P.16', for example.

There are probably many other people doing the same thing and using their own keywords. Wouldn't it be more sensible if we had a common list? Your CT Standards for symbols are very practical and useful — can you now do the same thing for indexing the contents of your magazine? Issue a standard list of keywords and print these at the head (or foot) of each item in the magazine. You could lead the way to a common system for all magazines and newsletters (and Prestel maybe). It does seem a bit ridiculous in the Year of Information Technology that I spend so much time cutting up bits of paper and sticking them in cardboard files! A common keyword system would make computer filing much easier.

Yours faithfully,
Dawn Walker
Somerset

(* You may have noticed that we have just altered the style of presentation in the magazine to incorporate standard headings for each article and program feature. A compromise I'm sure, compared with what you are actually after, but it is a case of using something like this or going to a full-blown indexing method as used by **Small Computer Program Index** or **The Index**, both of which cover **Computing Today** articles in synopsis form. Ed. *)

Dear Sir,

There I was, all ready to relish a little bit of fame — to actually see my name in print — and you blew it!!

I refer to the Softspot article, Tape Indexer, as published in the September issue of Computing Today. It would seem to be the fruit of some peculiar form of parthogenisis or spontaneous birth, bursting upon an unsuspecting world totally without the benefit of an author.

Oh well, never mind.

A couple of other things spring to mind thinking of the September issue. I have POKEd 62 into 59458 of a 3032 and it locks up the machine. I have **not** attempted it on my own 4032 (see page 53)! Also, looking at page 59, your note on PET jiffies — there are 60 to a second, not 50!

Yours faithfully,
Mike Lyall
Hampshire

PS With regard to your Printout in the August issue, I'll bet HRH must be chuckling quietly to himself.

(* Heads have rolled and pennance has duly been paid, we stayed away from the pub one lunchtime! Rumour has it that the initial letters of HRH's name give the real game away! Ed. *)

Dear Sir,

I write this letter in response to your request to 'tidy-up' the program which was included in an article dealing with 3-D Bezier surfaces, recently published in the series REFLECTIONS.

To my shock and horror I learned, by looking at the printed program listing, that we had sent you an old source listing by accident. The problem was further compounded by a few transcription errors and as a result, changes need to be made to quite a few program lines.

The affected lines are listed below as they should appear in the program.

```
   5  GOTO 1000
  10  INPUT "N BY M ?";N,M
  35  NEXT H,J
 260  X=(N-I):GOSUB 900
 270  J1=(A1/(A2*A3))*U^I*(1-U)^(N-I)
 320  K1=(B1/(B2*B3))*W^J*(1-W)^(M-J)
2055  PZ(Z,1)=S(3,C+H)
6270  HCOLOR=3:HPLOT PX(NO,1),PY(NO,
      1):FOR J=2 TO 4:HPLOT TO PX(NO,
      J),PY(NO,J):NEXT
7040  B1=A1*-WX(H)+WY(H):IF A1=0 THEN
      A1=0.001
7070  IF (X<=WX(H) AND (X>=WX(H+1)))
      OR (X<=WX(H+1) AND (X>=WX(H)))
      THEN W=W+1
7080  IF (Y<=WY(H) AND (Y>=WY(H+1)))
      OR (Y<=WY(H+1) AND (Y>=WY(H)))
      THEN W=W+1
```

Also, another correction needs to be made in the text. Under heading 'How To Use The Program', paragraph two, line four, a reference is made to Fig. 4. This should, in fact be Fig. 7a instead.

I sincerely regret any inconvenience that might have arisen as a result of the afore mentioned mistakes.

Yours faithfully,
Damien Skracic
Australia

Dear Sir,

Thank you for producing the best computing magazine in the UK.

However, may I be so bold as to ask you to publish a series of articles on programming in Pascal. You have obliged us so far this year with series on FORTH, BASIC and 'better' BASIC but Pascal is only present in the form of advertisements!

I have a NASCOM microcomputer with four (yes four!) Pascal compilers but I have little idea how to use them properly and which one is suitable for different needs. Indeed, I'm not sure if Pascal has any improvements over BASIC except speed and the apparently dogmatic phrase 'structured programming'.

I have tried to write Pascal programs, but beyond a certain complexity (about four procedures) there are so many 'errors' that it is pointless proceeding.

So please, a series of Pascal would be of immense value to me, and undoubtedly to many others. ▶

Thank you for hearing my prayer!
Yours faithfully,
Dr D J Plews MB ChB
West Yorkshire

(* Your prayers are indeed answered. Within the next few months we will have begun a four part introduction to the mysteries of Pascal and, although it is not specific to your NASCOM, this should help sort out some of the problems you've encountered. As a point of general interest, if you are a BASIC programmer making the move to Pascal there is a book called **Pascal from BASIC** by P J Brown. Published by Addison Wesley it costs £5.95 and seems to offer a different approach to the language from that used in some of the heavier titles. Ed. *)

Dear Sir,

On the subject of the ZX Spectrum's VAL$ function — I think I can alleviate your fears of the onset of madness.

There are two possible explanations for this seemingly useless function. Consider the following statement:

```
PRINT VAL$("1234ABC")
```

This probably does not give an error message but returns "1234".

Whilst writing a BASIC interpreter, I came across the standard function VAL, to which I added a Z80 subroutine which called a decimal to binary conversion routine, hence returning the value of the string, only to be told that it would not evaluate expressions within a string. To this end, I wrote an EVAL function for use in graph plotting routines (INPUT"ENTER FUNCTION";A$: Y=EVAL(A$), etc).

On further investigation I was told that the VAL function on the ZX81 did the equivalent of the EVAL function — is this the same on the ZX Spectrum?

My EVAL function calls a full expression evaluation routine and, because of this, the following statement would be prefectly legal:

```
PRINT EVAL("1+(25*(6+ZX))-PEEK(1024+X)")
```

Note the use of functions, brackets and variables. Now consider the following on the ZX Spectrum:

```
10  A$="VAL(A$)"
20  PRINT VAL(A$)
```

Yours faithfully,
D Adshead
Manchester

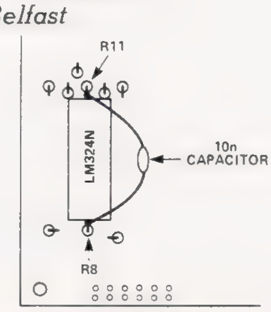
(* Sadly, the answer you have given appears to be even more confused than that provided by the Spectrum manual. The VAL function will evaluate an expression within quotes; VAL "2★3" returns 2★3 and using the suggested 'nested quotes' method on p59 of the manual produces even wierder results. So, overall the outlook for the VAL$ function is still not too good! Back to the straightjacket once more. Ed. *)

Dear Sir,

Stirred by Andrew Donald's letter in your August issue, I too found I could pick up our local BBC radio station when touching components in the sound amplifier area of my BBC Micro! The unpleasant buzz emanating from the small speaker seems to be common to most of the BBC computers I have encountered. However, the following cure may be of interest to other owners.

By soldering a 10nF (0.01uF) capacitor between the exposed ends of the vertically mounted resistors, R8 and R11, I found the buzz was greatly reduced in level, without affecting the audio output. These resistors are located at the bottom left-hand corner of the circuit board as viewed from the front of the machine, above and below the LM324N IC as shown in the diagram below.

Yours faithfully,
W N Watkins
Belfast



Dear Sir,

What has spurred my writing to you is the purchase of some equipment advertised in your magazine for some time. I refer to the Hobbit digital tape drives sold by Ikon. With two NASCOM 1s and an ever increasing data base, we were faced with the thought of splashing out on disc drives or slowing down our expansion. However, the Hobbit drives were an excellent compromise. Having added numerous bits and pieces to both NASCOMs and poreing over sometimes incredibly incomprehensible construction notes, I was pleasantly surprised to find that no modifications were needed to any of the boards in the NASCOM and only the wiring of one DIL socket for each drive (as we have two) and the connection of three further wires for the power requirements.

As you will have gathered, we have two of the above drives. To add further to my astonishment, the firm supplied not only the EPROMs coded for whatever starting address you wished but also details of the driver programs too! Using this information we have adapted our BASIC to dump strings (and retrieve them at 750 bytes per second, yes I said bytes!) up to the full capacity of the tape, which incidently is 50.5K. Therefore, with two drives, we now have an immediately accessable 101K. The tapes are double sided and actually hold 101K in total but to access the second side you have to manually remove it, re-insert and load the index again.

The system works in a similar way to that of disc drive systems, with an index of what's on the tape held in memory. What hardware do you need for all this, you ask? The answer is very little, the NASCOM plus a board that will accept 2708 EPROMS. To top it all the EPROMs will work with all the issues of NASCOM monitor, and either the NASCOM 1 or the NASCOM 2.

We had considered other makes of digital drives before this but the price put us off, and the size. The Hobbit uses the Philips digital tape drive and micro cassettes and is a mere four inch cube.

All this may sound like an advert but as a NASCOM user who has been used to getting ignored and considered as owning a toy computer, it is very gratifying to see that firms like Ikon and others are producing something that doesn't make beep-beep noises and actually does something useful in the low price bracket.

Yours faithfully,
G J McPhee
Paisley
Scotland

(* For those of you who might be tempted to think that this letter arises from the company itself rest assured that it is genuine, we checked. We currently have one of the units under test to see if it really is as good as everyone is saying and will be bringing you the report soon. As a postscript, we also understand that the company has just produced a new Operating System for the device which is significantly better than the one currently supplied. Ed. *)

Dear Sir,

The article 'Case Converter' by Tyler and Wright in which they describe a method of converting a TRS-80 microcomputer to support lower case is erroneous in certain respects. I would like to correct these errors which I hope you will publish.

First, most TRS-80 micros are not fitted with a character generator of type SCM 37350P but with one of the type MCM 6670P. This means that on power up a series of meaningless characters are produced instead of the letters of the familiar 'MEMORY SIZE?'. This is because bit six is no longer being synthesised and, as it is not on the data bus to start with, it will be missing completely. Thus, the different character generator produces a different part of its character set, which is not standard ASCII. Whatever is displayed on the screen will simply be unreadable, except for numbers, punctuation and graphics. To rectify the problem we need to set bit six at the correct time and this can be done by entering and running the BASIC program. This is not as difficult as it seems because numbers and punctuation appear correctly. Note, only lines 1 to 20 and line 50 should be run.

However, although the BASIC program gives upper and lower case characters, it will not support graphics and space compression codes. The machine code program will, but as shown defaults to lower case, giving upper case on shifted keys. I have, therefore, modified this program and added another routine which allows switching between the normal and the wierd character set. This program will have to be entered via an editor/assembler and it is interesting to note that the Tandy version produces ordinary text without a supplementary driver. Entry of this program should proceed as follows.

Gain access to an editor/assembler and type in the program as listed (without remarks if necessary). Save a couple of assembled copies on tape and then switch off the computer. Switch on again and press Enter to the garbled 'MEMORY SIZE?' message. The program resides in low RAM and adjusts the BASIC area pointers to suit. Type **SYSTEM** *(although you won't be able to read it) and press Enter. When the '*?' appears, type in the name under which you saved the program and press Enter. When the program has laoded from tape it will automatically run and that's all there is to it.*

The program provides upper and lower case characters, lower case on shifted keys, graphics, space compression codes, numbers and punctuation on first being run. However, by typing the word **GET** *in a program or in command mode, the character set will be switched to reproduce those wierd characters instead of letters. The new 'GET' instruction works as a toggle, switching between the two character sets each time it is executed. This can be useful in games, especially when one considers that both character sets may be displayed simultaneously (although they must be printed separately).*

If the procedure outlined here is followed then a useful set of extra characters will be at the user's disposal. This is both larger and more unique than Tandy's lower case conversion and so should make the computer more versatile. Please note that the program must be loaded every time the computer is turned on but that it occupies only 158 bytes and so should not pose too many memory problems. Note also that some other utilities may not operate with this routine in memory because the two overlap.

Yours faithfully,
S Rainey
Lancashire

(* When the lower case modification arrived we checked the theory of its operation against the Tandy system we own in the office and, as it performed as stated we, wrongly, assumed that it would operate on any TRS-80. A number of readers have written in to ask how to solve the apparent problem and it appears that the above provides the 'cure'. Our apologies for this oversight. Ed *)

```
4Ø16              ØØ1Ø         ORG   4Ø16
4Ø16 E9 42        ØØ2Ø         DEFW  INIT
42E9              ØØ3Ø         ORG   42E9
42E9 21 E3 Ø3     ØØ4Ø  INIT   LD    HL,995
42EC 22 16 4Ø     ØØ5Ø         LD    (4Ø16),HL
42EF 21 4D 43     ØØ6Ø         LD    HL,CHNGE
42F2 22 8Ø 41     ØØ7Ø         LD    (418Ø),HL
42F5 3E C3        ØØ8Ø         LD    A,ØC3
42F7 32 7F 41     ØØ9Ø         LD    (417F),A
42FA 3E ØØ        Ø1ØØ         LD    A,Ø
42FC 32 7A 43     Ø11Ø         LD    (TEST),A
42FF 21 7C 43     Ø12Ø         LD    HL,FINISH+1
43Ø2 AF           Ø13Ø         XOR   A
43Ø3 77           Ø14Ø         LD    (HL),A
43Ø4 23           Ø15Ø         INC   HL
43Ø5 77           Ø16Ø         LD    (HL),A
43Ø6 22 A4 4Ø     Ø17Ø         LD    (4ØA4),HL
43Ø9 23           Ø18Ø         INC   HL
43ØA 77           Ø19Ø         LD    (HL),A
43ØB 23           Ø2ØØ         INC   HL
43ØC 22 F9 4Ø     Ø21Ø         LD    (4ØF9),HL
43ØF 22 FB 4Ø     Ø22Ø         LD    (4ØFB),HL
4312 22 FD 4Ø     Ø23Ø         LD    (4ØFD),HL
4315 21 2Ø 43     Ø24Ø         LD    HL,START
4318 22 1E 4Ø     Ø25Ø         LD    (4Ø1E),HL
431B C3 CC Ø6     Ø26Ø         JP    6CC
ØØØ2              Ø27Ø  POINT  DEFS  2
432Ø DD 6E Ø3     Ø28Ø  START  LD    L,(IX+3)
4323 DD 66 Ø4     Ø29Ø         LD    H,(IX+4)
4326 DA 9A Ø4     Ø3ØØ         JP    C,49A
4329 DD 7E Ø5     Ø31Ø         LD    A,(IX+5)
432C B7           Ø32Ø         OR    A
432D 28 Ø1        Ø33Ø         JR    Z,GO
432F 77           Ø34Ø         LD    (HL),A
433Ø 79           Ø35Ø  GO     LD    A,C
4331 FE 2Ø        Ø36Ø         CP    2Ø
4333 DA Ø6 Ø5     Ø37Ø         JP    C,5Ø6
4336 FE 8Ø        Ø38Ø         CP    8Ø
4338 D2 A6 Ø4     Ø39Ø         JP    NC,4A6
433B FE 4Ø        Ø4ØØ         CP    4Ø
433D 38 ØA        Ø41Ø         JR    C,LOOP1
433F CB 6F        Ø42Ø         BIT   5,A
4341 28 Ø4        Ø43Ø         JR    Z,LOOP
4343 CB EF        Ø44Ø         SET   5,A
4345 18 Ø2        Ø45Ø         JR    LOOP1
4347 CB AF        Ø46Ø  LOOP   RES   5,A
4349 C3 7D Ø4     Ø47Ø  LOOP1  JP    Ø47D
434C ØØ           Ø48Ø         NOP
434D D9           Ø49Ø  CHNGE  EXX
434E Ø8           Ø5ØØ         EX    AF,AF'
434F 3A 7A 43     Ø51Ø         LD    A,(TEST)
4352 FE 6Ø        Ø52Ø         CP    6Ø
4354 2Ø 12        Ø53Ø         JR    NZ,NOGO
4356 21 2Ø 43     Ø54Ø         LD    HL,START
4359 22 1E 4Ø     Ø55Ø         LD    (4Ø1E),HL
435C 3E ØØ        Ø56Ø         LD    A,Ø
435E 32 7A 43     Ø57Ø         LD    (TEST),A
4361 2A 1E 43     Ø58Ø         LD    HL,(POINT)
4364 23           Ø59Ø         INC   HL
4365 Ø8           Ø6ØØ         EX    AF,AF'
4366 D9           Ø61Ø         EXX
4367 C9           Ø62Ø         RET
4368 21 58 Ø4     Ø63Ø  NOGO   LD    HL,1112
436B 22 1E 4Ø     Ø64Ø         LD    (4Ø1E),HL
436E 3E 6Ø        Ø65Ø         LD    A,6Ø
437Ø 32 7A 43     Ø66Ø         LD    (TEST),A
4373 2A 1E 43     Ø67Ø         LD    HL,(POINT)
4376 23           Ø68Ø         INC   HL
4377 Ø8           Ø69Ø         EX    AF,AF'
4378 D9           Ø7ØØ         EXX
4379 C9           Ø71Ø         RET
437A ØØ           Ø72Ø  TEST   NOP
437B ØØ           Ø73Ø  FINISH NOP
ØØØØ              Ø74Ø         END
```

This program listing is the one referred to in the letter by S Rainey from Lancashire.

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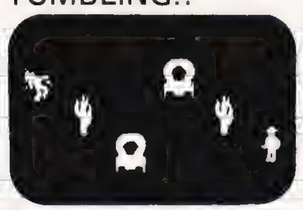

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Henry Budgett and Chris Palmer

COMMODORE'S 64

It might look like a VIC-20 but inside the case resides a whole host of extra features plus 64K of memory. Our review team brings you the vital details.

In the beginning there was the PET, and it was seen to be good. Then came the 3000, 4000 and 8000 systems and they were better. At last the big C realised the need for a smaller machine for the home market and the VIC-20 was introduced, but still the older machines flourished despite their outdated architecture and their lack of advanced features. So, the big C decreed that a whole new range of machines should be created to re-establish the company's dominance of the market.

The first of these new systems to arrive is the Commodore 64 which received its Press debut at the Hanover Messe earlier this year. Admittedly, the system was then still in the pre-production stage but it certainly looked interesting and appeared to offer a new slant on the way in which Commodore designed its systems. Looking very similar to the VIC-20, indeed the only distinguishing differences are that the 64 has two control ports on the right-hand side and a much smaller cartridge slot at the rear, it is based around the new family of devices produced by MOS Technology, the corporation who brought you Chuck Peddle (and the 6502).

DESIGN PHILOSOPHY

As its name suggests, the Commodore 64 is equipped with 64K of RAM based on Mitsubishi 16-pin 64K by 1 devices and is essentially a 'soft' machine. I say essentially because the BASIC is loaded from ROM by default thus making it look like a conventional ROM-based system. The processor is the new 6510 device and that is by no means the end of the new silicon inside. To control the video there is a new variation of the VIC chip that produces and controls programmable objects known as MOBs (sprites to the rest of us) and the new, all-singing, all-dancing SID chip which produces sound effects, music and the now obligatory beeps and whistles. Apart from these major devices there is a regular sprinkling of I/O devices and just a small quantitiy of ordinary logic.

The whole design is based on the new generation chips and seems to make effective use of the facilities they offer — the only question being whether people actually want those facilities in the first place! Personally, we have found it rather difficult to place the machine in a given area of the market. It is equipped with the capability to produce fantastic games and display graphics, it will handle all the domestic add-ons like a cassette recorder, small printer and joysticks, and yet it also offers the possibility of being used for serious purposes with its serial port, excellent keyboard and capability of driving a monitor as well as a TV. If a company was only producing one system which had appeal across a wide spectrum of the market, then one would say that this was perfectly acceptable and, indeed, a sensible approach to take. However, Commodore are also launching the 500 series, the 700 series, the VIC-10, the VIC-30 and, according to recent reports, there appears to be at least two more systems being currently examined for their market potential. Now, the dividing line between the VIC-30, the Commodore 64 and the 500 series is a remarkably thin one in our opinion and perhaps only time will tell if they've got their strategy right.

PANDORA'S BOX

At this point it is only fair to point out that the Commodore 64 we reviewed was an American model. Normally, as you are probably well aware, we would not look at a non-UK version of a system but, apart from the power supply running at 110 volts and the TV picture appearing in NTSC format, we were assured that the guts of the system were identical to UK models. Certainly, when we opened up the system there was no indication of any board modifications or lashed up ROMs. It was a clean production unit with all the patches configured for the US.

While this meant that we were able to receive a Commodore 64 earlier than we had expected, which was good news, it meant that we had to obtain an American standard power unit and TV. While the former proved no problem at all, the latter complication was only solved by the helpful attentions of Hitachi who kindly provided one of their new multi-system TV/monitors for the duration. Sadly, however, the picture quality still proved insufficient to produce screen photographs of the graphics in action — a treat for which you will have to be patient!

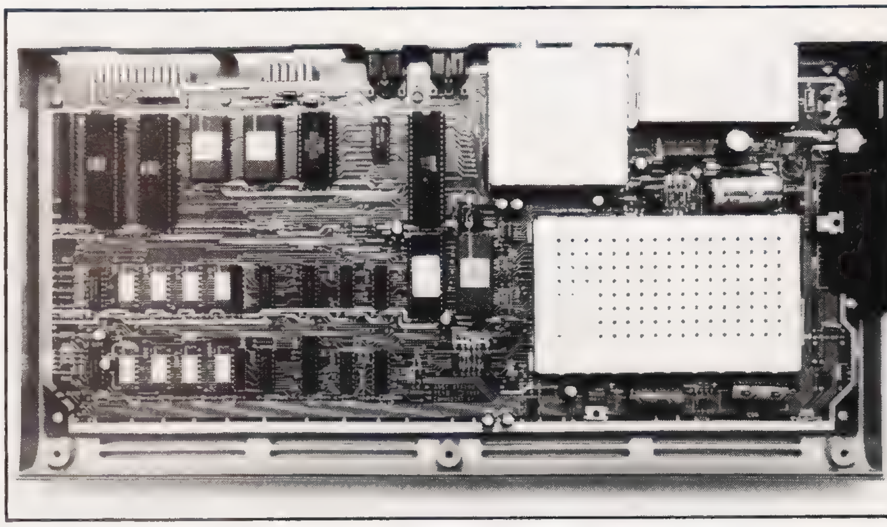
The VIC-style case is coloured a light chocolate brown for the Commodore 64 and is well constructed. The keyboard is excellent and has a nice sculptured feel. The angle at which it is set is possibly a little too steep but that's really something that only long term use will reveal. None of the sockets on the rear panel were labelled as to their function, a serious oversight as they have managed to label the side connectors quite adequately. The rear panel connectors comprise the cassette, user, serial and expansion ports together with the monitor socket and the TV phono socket. Also recessed neatly into the panel is a somewhat mysterious switch which changes the UHF channel output to something other than 36; what channel it actually is the manual does not bother to say!

Inside the case, as we have already mentioned, the construction is excellent, the PCB is well laid out and all the nasty, high frequency modulating bits are well wrapped up in metal boxes. The case is well ventilated but none of the regulator devices are mounted on heatsinks. With the actual transformer being elsewhere, the case size can be kept down along with much of the heating problems. All the major ICs, with the exception of the RAMs, are socketed for easy replacement — should the need arise.

Along with the keyboard/CPU unit comes the power pack, a heavy duty phono-to-phono lead and an aerial tapping box, although it is likely that the latter two will be replaced by a UK standard device when you open the box here! There is no supplied cassette lead as the 64 is designed to operate with the usual CBM/VIC type cassette unit which has its own integral lead and power cable. The manual which came with the American review sample will, as far as we can tell, be the one supplied in the UK and more will be said about this in a later section.

LANGUAGE TALK

The Commodore 64 is equipped, to all intents, with an identical version of BASIC to its predecessors, V2 BASIC from the VIC-20 to be precise. Despite the fact that this is a third generation system there are no structured programming functions such as IF . . . THEN . . . ELSE and, indeed, the language is barely different to that found on the oldest of PETs. Now, while this gives a remarkable flexibility to the system in that, with a minimum of effort, software can be converted to the 64



The internal layout of the 64 reveals the use of much new chippery. The RAM is at the bottom left, all 64K of it! Note also the use of shielding around the HF sections.

it does make one wonder about the lack of progress.

The Commodore 64 screen is based on the 25 lines of 40 characters format which is so familiar to users of microcomputer systems, but the address map has been moved and there is a second area of screen memory set aside for the colour information. The position map lies between 1024 and 2023 and the colour map lies between 55296 and 56295. The choice of colours has been expanded to 16 (including black and white) and the colour value of any location on the screen can be set by adjusting the corresponding location in the colour map.

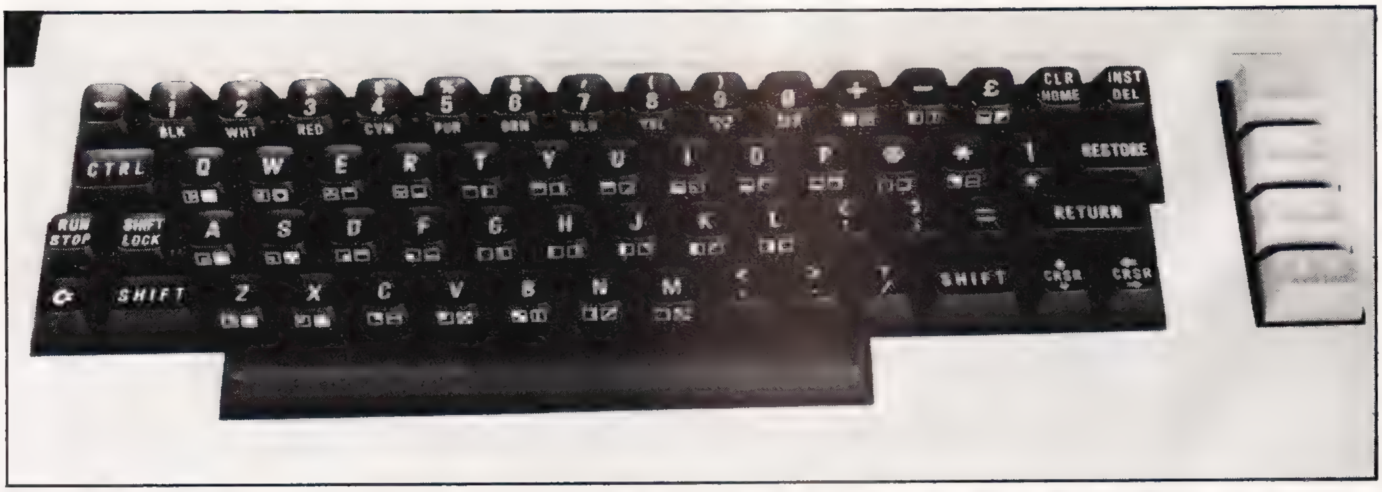
Now, as you may have gathered from the introduction to this piece, the Commodore 64 is equipped with 64K of RAM and yet, when you turn on the system, you only appear to have 38911 bytes left! Why, you may well ask. The reason is that the system is designed to be capable of running under languages other than BASIC; COMAL, LOGO, FORTH, UCSD Pascal and PILOT being likely possibilities. However, rather than taking the Sharp approach where the language has to be loaded into an empty system from disc or tape, Commodore have opted for the ROM-based approach. Inside the Commodore 64 is a BASIC ROM which, provided it is given no other instructions, inserts itself into the memory map at power up. There is actually a noticeable delay at power on while the operating system tests the complete complement of RAM.

So, as it comes, the Commodore 64 is equipped with a perfectly ordinary version of BASIC which offers no extra facilities, doesn't support Hi-Res graphics or sound (despite the fact that both facilities are built-in to the system), and appears to be no better than the language offered on the original 2001 series PET. Surely this is not really as it seems? Well, if you have been used to a VIC-20, you will already be aware of the fact that the additions to BASIC to give Hi-Res graphics come in an expansion cartridge so it is quite likely that you will accept these constraints. If, however, you are used to something like a BBC Micro, Dragon 32, Tandy Color Computer or even a ZX Spectrum then these restrictions may well annoy you considerably.

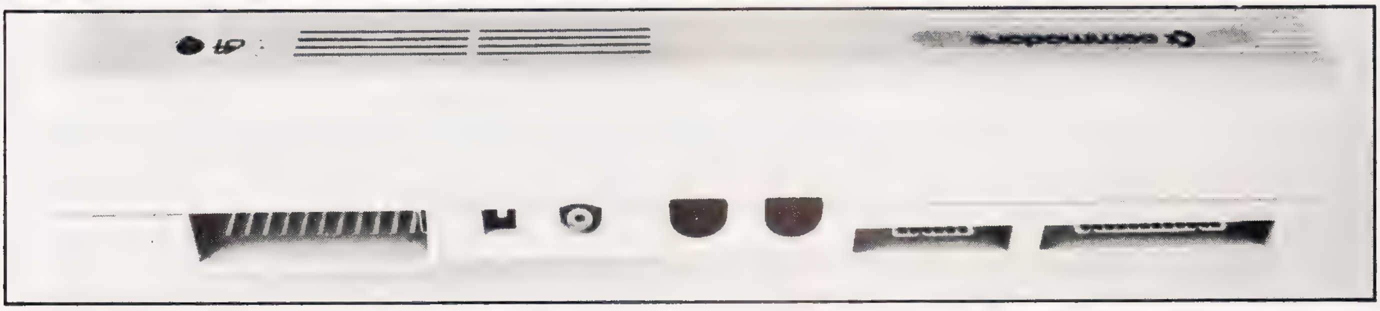
SOUNDING OFF

Equipping home computers with sophisticated sound generating facilities is no new thing. Keyboard bleepers have been billed as music facilities for almost as long as we've been writing reviews, but on the Commodore 64 the provision of the SID chip gives a whole new dimension to the art. The controls for the SID device are many and varied (they would probably rate an entire manual on their own) but the first thing that you notice is that all the operations are handled by memory locations rather than as reserved BASIC words. If the manual tells you about something called the Waveform Register, and it's something that you are going to be using quite a lot, why on earth didn't they create a system variable called WAVEFORM? But such ideas are too fancy it seems, us mere mortals have to remember that the blasted thing is location 54276 and POKE to it. One register you might live with, but there are 28 registers controlling three voices and they all require thinking about as they are often shared — you quickly learn all about masking and bit manipulation techniques on this machine!

As to the sound that the Commodore 64 actually produces,



The keyboard layout is essentially the same as that on the VIC-20. Graphics legends are clearly marked on the key fronts.



Rear pane socketry from left to right comprises cartridge port, channel switch, UHF output, monitor and serial port sockets, cassette connector and user port.

well, it's versatile and really quite pleasant. You can take the output directly to the TV set as the modulator is a sound plus vision type, or you can take a direct audio feed from the monitor socket to drive the monitor's amplifier or even your Hi-Fi. It would take more, much more, than the pages available in this magazine to cover the possible ways in which you can manipulate the sounds which the SID can generate but, surprisingly, the actual characteristics of the SID are not too different to that mainstay of computer music devotees — the GI AY-9-8910! Users of the BBC Micro who have successfully acquired their new manuals and mastered the SOUND and ENVELOPE commands can bask in the knowledge that their system is still the most sophisticated.

COLOUR CRAZY

A logical extension to any system offering Hi-Res graphics capability in colour is to provide some means of manipulating objects once they have been created. The first popular system to offer this sort of facility was the Apple II which supported shape tables but was not exactly easy to use. The first system to offer usable facilities along these lines was the Atari 400/800 system and the defined pictures were christened Players, sprites to the rest of us. The theory is that you create a picture using the smallest pixels available, generally the actual character dots, which is then stored. This image can now be retrieved and positioned anywhere on the display, moved, and made bigger or smaller as you require. Because you can often create several of these sprites, rules have to be established as to their priority — which ones pass in front of others or *vice versa*.

The Commodore 64's VIC chip offers up to eight simultaneous sprites (in BASIC) each of which is based on a 24 wide by 21 deep block. In sprite mode, the screen is transformed into a Hi-Res format of 512 dots by 256 dots and the sprites can be positioned at any point, even over the border if you wish to make them appear and then disappear. Each sprite is programmed in the form of a DATA statement whose values are then loaded into an area of memory reserved for user defined characters. The control of the size, shape and priority of each sprite is handled by no less than 46 special registers which have to be PEEKed and POKEd in BASIC. Sadly, as with the music facilities, there is no special set of reserved words to control these registers, it all has to be done the hard way but, doubtless, an optional cartridge will appear soon to make the use of the sprites and the Hi-Res screen area a simpler matter. For anyone who has experienced the heartache of programming the sprite facility on the Atari, the Commodore 64 system will seem a whole lot easier (for a start it can be done at a decent speed in BASIC), but is far from ideal. The sprite register map is provided as an Appendix to the manual and doubtless some enterprising individual will soon produce a wipe-clean plastic version together with a book of sprite planner sheets — it will probably sell like hot cakes!

I have referred to the programmable graphics blocks throughout as sprites because that name is at least familiar. It is also the word used in the manual which accompanied the review Commodore 64 system but the indications are that in the UK, the equally correct word will be MOB or Movable Object Block — it appears that some enterprising person at Commodore has registered both sprite and MOB as something which only appears on his make of computer!

WORDS OF CAUTION

In the very early days of Commodore, a pair of employees in the UK were so horrified by the quality of the manual provided by the American company that they completely re-wrote it for the UK market. What they produced certainly wouldn't have won prizes by today's standards of documentation but it was a definite improvement. When the VIC-20 appeared a number of reviewers criticised its manual as being insufficient and, considering the vast number of extra facilities provided on the Commodore 64, it comes as a bit of a shock to find a mere 165 pages of information being called a manual.

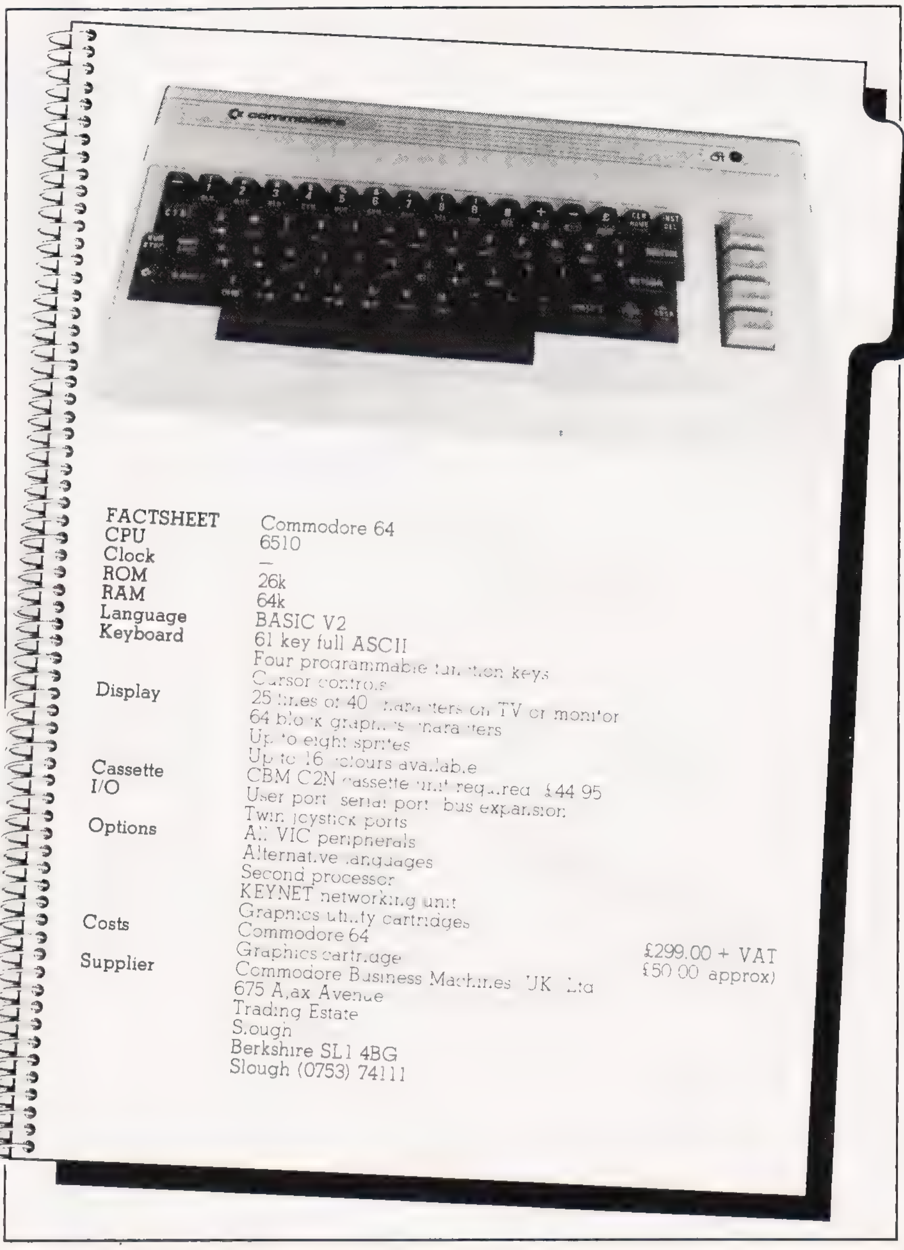
There is to be an extended manual, we hope, and the sooner it appears the better, as the supplied User's Guide is, to put not too fine a point on it, awful! While it covers the basic points of the system and outlines the commands available and the facilities provided, it introduces ideas that a first time user is unlikely to grasp. If you are already familiar with micros, whether Commodore's or not, it is almost equally annoying in that it fails to provide comprehensive information about monitor addresses, memory areas and the like. I'm sure that it is OK for the American market where systems like this are generally treated as super 'games/toys' (at least the VIC-20 was) but in the UK, we tend to take a much deeper interest in the actual workings of the hardware. So, an urgent need for a better and more comprehensive manual will probably be felt. Whether Commodore manage to produce it in time or it is done independently we'll have to wait and see.

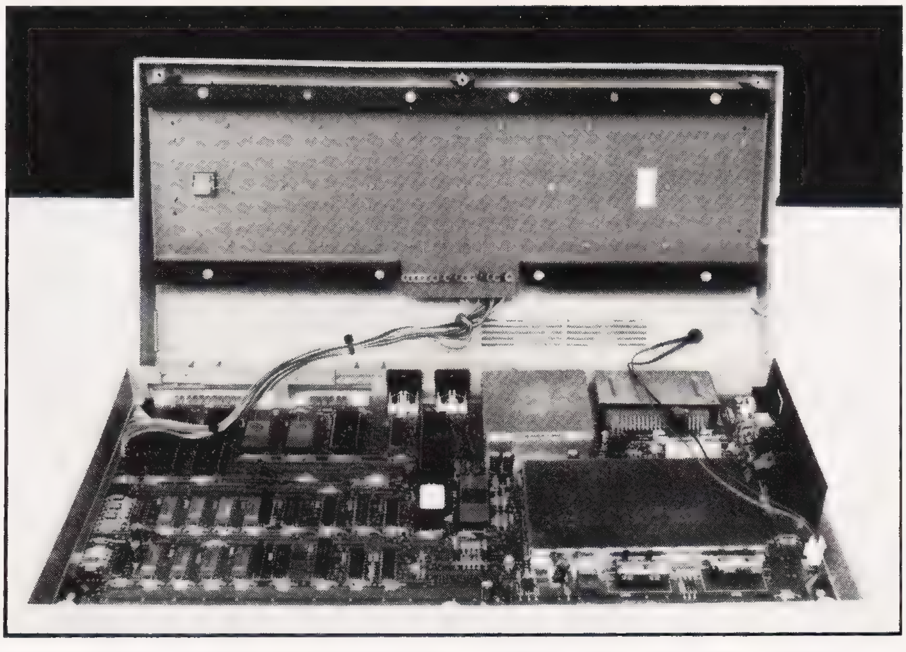
IN THE END

As a machine to summarise, the Commodore 64 is not the easiest of beasts. Quite how Commodore are going to market it is not yet obvious. Will it be treated as a PET replacement (the 500 series is probably a better bet for that) or will it try to fill a gap between the VIC-20 and the existing 4000 series? In terms of price it must be seen as a direct competitor to the BBC Model A and yet its BASIC and overall facilities are not as comprehensive. It does, however, have the backing of the entire existing Commodore range: discs, printers, add-ons and most importantly of all, software.

With the possibility of other languages, the potential for networking through the new Keynet exists and with its nice compact styling, I have a feeling that it could be used as a classroom terminal or, possibly, as a general purpose intelligent terminal. The logical choice of host computers would be the new 700 series systems, specifically the 710 and 720 but, as yet, there has been no indication from Commodore as to this possibility.

The Comodore 64 will undoubtedly sell, the strength of the Commodore name alone will probably guarantee this, but the market may well have to be created for the system rather than the other way around.





The keyboard and power light mounted on the top half of the case are easily unplugged allowing ready access to the interior. The two games ports and the power input can be seen at the rear right.

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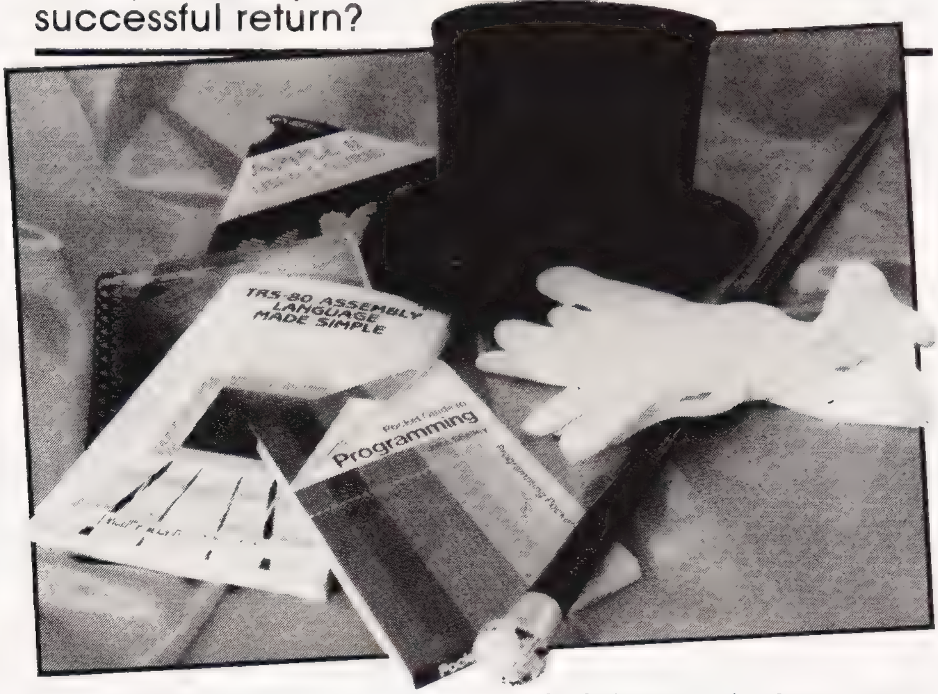


After spending so much effort in previous parts of this series describing how to go about writing programs that behave predictably, it might seem counter productive to spend this month's episode considering how to make programs *unpredictable!* However, since the start of the personal computer boom, playing games has been a major occupation and most computer games involve an element of randomness.

Randomness in programs may be something that a user takes for granted but it can pose quite a problem even for the most experienced programmer. The trouble is that using randomness in programs depends upon knowing about something other than programming — ie probability.

RANDOM COMPUTERS?

The idea that a computer can be random in the same way as a thrown coin or a rolled dice is a strange one. A computer is a very complex mass of electronic circuitry but at no point is its operation 'vague' in the same way as the behaviour of a thrown coin. If you know a computer's state at any moment, you can predict its state at any time in the future. This very fact is the basis of program debugging — for if we couldn't predict what the computer ***should*** do, how would we ever know that a program was behaving 'not as expected'! The first law of programming is that:

A working computer is absolutely predictable

and its obvious corollary is that 'an unpredictable computer is a broken computer'!

All this talk of absolute predicability seems to widen the gulf between computers and randomness rather than reconcile them. However, the key to the problem lies in the previous suggestion that the flight of a coin was 'vague'. The toss of a coin is entirely predictable — in theory at least. In practice, its behaviour is so complicated that it is beyond the powers of most people to predict how it will land.

This sort of randomness is different from most people's idea of randomness. A truly random event is one that is unpredictable in theory as well as in practice. An event that we regard as being random just because it is too difficult to predict deserves a different name. 'Pseudo-randomness' is the term that has been coined to cover this class of happening (pseudo meaning false or imitation.) Most of the things that we think of as being random are in fact pseudo-random although sometimes it's difficult to decide. The point is that, in practice, there is little difference between randomness and pseudo-randomness. If something is too difficult to predict, it matters little that it is theoretically possible to predict! You may be wondering at this point if there is anything that is truly random and theoretically impossible to predict. The answer is yes, but you have to look into the realm of atomic physics before you find it!

PSEUDO-RANDOM NUMBERS

The idea that you might bet on a single number can be extended to the case where a computer produces a whole list of numbers which are unpredictable (rather like tossing a coin more than once). If this list or sequence of numbers is going to prove useful as a source of randomness then it must be, for all practical purposes, unpredictable. Now the trouble is that most of the sequences of numbers which come out of a computer are predictable or at the very least they show general patterns of behaviour, ie they tend to increase and decrease in regular ways.

A sequence of numbers is said to be pseudo-random if:

1) there is no 'practical' way of predicting the next number in the sequence, and
2) there are no 'patterns' of any sort in the sequence that could be used to 'guess' the next number in the sequence.

This definition sounds reasonable enough — the only trouble is that it is entirely at the mercy of the words 'practical' and 'patterns'. What one person might find practical may be another's impossibility! And as for the word 'patterns' well . . .!!!

PRANGING IT

The emphasis has now moved away from producing random events or happenings to something a little more abstract — a pseudo-random sequence of numbers. As we shall see later, given a pseudo-random number sequence you can make any event happen seemingly at random with any given probability, so producing such a sequence is of great practical importance. A program which produces pseudo-random numbers is often called (very reasonably) a Pseudo Random Number Generator or PRNG for short. It is very much more difficult than you might think to write a PRNG. The condition about the number not being easy to predict is simple enough — for example, how many people can compute SIN(x) in their heads?! The other conditions cause the problem because most calculations, no matter how complex, tend to produce sequences of numbers which show a regular pattern.

One of the first PRNGs, the mid square method, was suggested by the mathematican and computer scientist Von Neumann in 1951. It is fairly easy to use but it has a tendency to produce numbers of the form 00XY and XY00 periodically. Each number in the series is determined by squaring the previous number in the series and throwing away all but a fixed number of the middle digits of the result. For example, if we are generating four digit random numbers and the last number was 5069, the next number is given by squaring 5069, giving 25694761 and then take the middle four digits ie 6947. The following short BASIC program implements the mid square method:

```
10  INPUT "STARTING VALUE";A
20  A$=STR$(A*A)
30  A=VAL(MID$(A$,INT(LEN(A$)/2),4)
40  PRINT A
50  GOTO 20
```

(STR$ is a function which converts numbers to strings and MID$(string, I, J) extracts the substring of length J starting at the Ith character.)

CONGRUENTIAL PRNGS

Although the mid square method serves as an illustration of how a complex calculation can produce a pseudo random sequence, it's not the best or the most popular method used today. This position is held by the so-called 'congruential' method. Although this method has the sort of name that might make you hide behind your computer, it is not much more difficult to understand than the mid square method. A congruential generator produces the next number in the sequence by multiplying the previous result by a constant and then finding the remainder after dividing by a second constant. The quality of the random numbers produced depends very much on the choice of the two constants used and it varies from hopeless to excellent! The BASIC program given below implements a congruential PRNG which was used on one of the first computers — ENIAC.

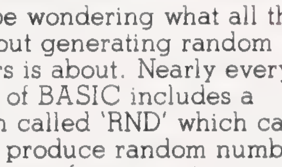
```
10  INPUT "STARTING VALUE";A
20  A=A*23
30  A=A-INT(A/100000001)*100000001
40  PRINT A
50  GOTO 10
```

In this case, the first constant is 2 and the second is 100000001. Line 30 works out the remainder when A is divided by the second constant.

One other feature of congruential PRNGs is that the quality of the random numbers that they produce depends on the starting value as well as the two constants. For example, to see a ***very*** non-random sequence try entering 0 in answer to line 10 in the above program!

RND AND RANDOMISE

If you know BASIC at all well you might be wondering what all the fuss about generating random numbers is about. Nearly every version of BASIC includes a function called 'RND' which can be used to produce random numbers in the range from zero to one and is as easy to use as SIN or COS. This is, of course, very useful but it does tend to lull one into a false sense of security — of course the numbers are random, they were produced by RND weren't they ?!? The sad fact of the matter is that:



RND doesn't always produce numbers that are random enough

The BASIC random number generator isn't any different from the PRNGs that we have been considering — they are just as fallible. The big advantage of the RND function is that, as part of BASIC rather than a program written in BASIC, it is very fast.

On a more practical level, RND presents a problem to any programmer trying to write programs which can be run on different versions of BASIC. The trouble is that there is no standard for the meaning of any parameters which are allowed in RND. Some versions of BASIC don't allow any parameters (eg Sinclair BASIC), some need a − 1 as a parameter to produce random numbers (eg Microsoft) and others allow the parameter to control the range of numbers produced (eg BBC BASIC). The safest thing to do is to assume that RND will produce numbers in the range 0 up to but not including 1 (I don't know any full versions of BASIC for which this isn't possible) and just face up to the fact that when converting programs, you may have to change all your RNDs to RND(− 1)s or vice versa.

The BASIC function RND should seem perfectly straightforward by this point, but most BASICs also have an associated command RANDOMISE, which seems to be an unnecessary complication. A lot of BASIC manuals recommend that if you want ***really*** random numbers you should always use the RANDOMISE command before using the RND function. This often strikes programmers as a rather strange idea — either the numbers from RND are random or they are not and if they are, how can RANDOMISE make them more random? The answer to this sort of question should now be obvious by thinking about RND as just another PRNG. If you look at either of the two BASIC programs given earlier, you will see that you are invited to give a value to start the sequence off.

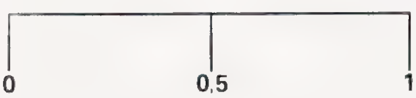
This value is often referred to as the 'seed' because the rest of the random sequence 'grows' from it. If you start a PRNG off using the same seed then you will get the same sequence of numbers. The BASIC function RND is no different from any other PRNG and it needs a seed to start it off. Just think for a moment where this seed might come from. Ideally, the seed should be random because we don't want to use exactly the same sequence of numbers every time the computer is switched on. This would make games boring to say the least! However, where do you get a random number ***from*** to start the random number generator off?

The answer is that the RANDOMISE command starts the random number generator off with a seed that is obtained from an area of the machine's memory where the value is constantly ▶

changing. What area of memory this is, varies from machine to machine — in most it contains a number related to how long the machine has been switched on. (Sinclair users note that everyone else's RANDOMISE is your RANDOMISE 0.)

USING RND

Given that the BASIC function RND is good enough (and for most applications, especially games, it is) how do you go about using it to produce random events? Let's suppose that we need to choose between one of two things that a program might do such that each is equally likely. RND returns a number in the range 0 to (but not including) 1 and as this sequence is pseudo-random, each number in this range is equally likely to 'come up'. If you consider the interval from 0 to 1:



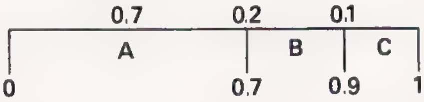
you should be able to see that the number that RND produces is equally likely to fall into the range from 0 to 0.5 as it is from 0.5 to 1. In other words, RND <0.5 will be true about half of the time and this is exactly what we need. So the statement:

```
IF RND<0.5 THEN <action 1> ELSE
<action 2>
```

will cause the program to 'do' action 1 and action 2 at random and roughly equally often. This leads to the simplest and perhaps most often written random program:

```
10  RANDOMISE
20  IF RND<0.5 THEN GOTO 50
30  PRINT "HEADS"
40  GOTO 60
50  PRINT "TAILS"
60  PRINT "PRESS ENTER/RETURN FOR
    ANOTHER THROW"
70  INPUT A$
80  GOTO 20
```

This is fairly straightforward but the problem which causes most difficulty is in extending this 'two-event' case to making a number of things happen possibly with different rates or probabilities. In fact, this is not at all difficult once you realise that the probability of getting a value of RND in any interval is proportional to the length of the interval. For example, suppose we want to a program to choose between one of three different alternatives A, B and C, such that A should happen 10% of the time, B should happen 20% of the time and C the remaining 70% of the time. If the interval between zero and one is divided up in the following way:



then the number produced by RND will fall in the interval A, 70% of the time and in B, 20% and in C, 10% of the time. This is exactly what we need and translating this into the most economical set of IF statements gives:

```
10  R=RND
20  IF R<0.7 THEN GOTO <action a>
30  IF R<0.9 THEN GOTO <action b>
40  <action c>
```

The logic behind this program is that the first IF detects R smaller than 0.7 and the second IF detects a value of R smaller than 0.9 (but it only gets the opportunity to do so if the first IF was false, ie if R was greater than 0.7). This means that the second statement following the second IF is only carried out if R is greater than 0.7 and less than 0.9 which is exactly what we want.

In general, if you have N different events and the first must happen P1 of the time and the second P2 and so on to PN, then you can program this as:

```
R=RND
IF R<P1 THEN <action 1>
IF R<P1+P2 THEN <action 2>
IF R<P1+P2+P3 THEN <action 3>
.......
```

RANDOM RANGES

Sometimes, rather than using RND to choose between a number of possibilities, it is useful to change the number produced by RND to lie in a range other than 0 to 1. For example, if you want to write a program which will mimic the roll of a dice, you could use the method give in the last section with six equally likely events or you could change the 0,1 range of RND to 1 to 6. This is just a matter of simple arthimetic. If you want to generate a random number in the range from a up to but not including b then use:

```
RND*(b-a)+a
```

You can test that this works by working it out with values of zero and just less than one for RND. If you want to produce integers (whole numbers) from a to (and including) b, use the following:

```
INT(RND*(b-a+1)+a)
```

For example, in the case of the dice program, a is 1 and b is 6 so:

```
10  PRINT INT(RND*6)+1
20  GOTO 10
```

will print random integers in the range 1 to 6.

TESTING RANDOMNESS

Any program which involves randomness is very difficult to fully test. The reason for this is two-fold. First, if any of the parts of the program are carried out only very occasionally, you may wait a long time before you see them in operation. Second, even if you do see a section of the program in operation and an error comes to light, it may be difficult to repeat the exact conditions that caused it. There are no complete solutions to these problems and as a consequence, you have to allow extra time for debugging any program which contains randomness. There are two things that you can do to help with the problem, however. You can use RANDOMISE or a particular parameter value in RND (which depends on the version of BASIC that you are using) to set the value of the seed at the start of the program. This will force the random number generator to always start from the same value and means that you can repeat any errors by re-running the program. Another technique which is worth trying is to replace the RND function by constants that will force the program to go through each and every section in turn. In practice, there are often good reasons why testing 'modified-easy-test' versions of a program is not possible, eg it destroys any interactive aspect of a game.

A SERIOUS SIDE

Although the emphasis has been on using randomness in games, the time has come to point out that there are other uses for the RND function. Most computer games are based upon some aspect of the real world. A program which plays a card game, for example, is copying something that happens with real cards using nothing but programming logic. This idea of modelling, or simulating, can be extended to things other than games. For example, you could write a program to simulate the way a nuclear reactor works and find out the best way to run it by 'playing' with the program. If you think that this is far-fetched then all I can say is that putting the real world inside a computer is one of the growth areas of computing.

By now you should have realised that we can structure programs! But, what on earth are data structures? To solve this elementary riddle you'll need to read next month's article.

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Computing Today

CLUB CALL

Here we are again with another round-up of clubs and user groups. It has been very encouraging to monitor the overwhelming response to this page — however, if you wrote in and you don't see your club in print, never fear, it'll be here as soon as we can fit it in!

If you would like your club to be included on this page, simply write to us at:

Club Call,
COMPUTING TODAY,
145 Charing Cross Road,
London WC2H 0EE.

We would be very happy to hear any details of your club: times of meetings, newsletters, etc. And, if you don't see a club near you, why not write in and see if any readers in your area would like to start up a new club with you.

SOUTHERN GAS MICRO CLUB
Floor A1,
Management Services,
Southern Gas RHQ,
80 St Mary's Road,
Southampton.
Tel: 0703-824648 (Ian Smith) or
0703-824496 (Andrew Craddock)

The club is open to any employee of Southern Gas and meetings are held monthly at the Southern Gas RHQ in Southampton. Members own a variety of machines including ZX81s, ZX Spectrums, BBC Micros, Acorn ATOMs and VIC-20s to name a few; many of these micros will be available for members to use at the meetings. The club also produces a bi-monthly newletter called Microcosm which contains club news, reviews and programming hints.

THE DAI MICRO USER GROUP
16 Douglas Street,
Atherton,
Manchester M29 9FB.
Tel: 0942-876210
Contact: Dave Atherton

Dave Atherton is in the process of setting up this club and needs your help. So, if you're interested, write or 'phone him, and don't forget to tell him what you want from the newsletter as he is quite keen to make its contents best reflect the interest of the members.

TAUNTON COMPUTER CLUB
Somerset College of Arts & Technology,
Taunton,
Somerset.
Contact: Dawn Walker

The club has now entered its second year of operation and boasts access to a wide variety of microcomputers available through the College. The subscription is about 25p a week and meetings are held regularly at the College. The club also produces a newsletter which details many of the club's forthcoming events, including various coach trips to exhibitions and shows.

ABERGELE MICROCOMPUTER CLUB
c/o Rosalski Computer Bureau Ltd,
Head Office,
Sutherland House,
Water Street,
Abergele,
Clwyd LL22 7SH.
Tel: Abergele 826020
Contact: Paul Pearse

The club caters for a wide range of interests from robotics using a ZX81 to programming on the TRS-80, etc. For further information regarding dates and locations of meetings, contact Paul Pearse on the above telephone number.

MID-CHESHIRE COMPUTER CLUB
Providence House,
222 Townfield Road,
Winsford,
Cheshire CW7 4AX.
Tel: 060-51374
Contact: Dave Clare

Meetings are held at 7.30pm on the second Friday of each month in the main Winsford Library in the Winsford Town Centre Precinct.

RAF RHEINDAHLEN COMPUTER CLUB
11SU,
RAF Hehn,
BFPO40,
Germany.
Contact: A Robinson

The club meets monthly and would welcome any contact with other clubs in Germany.

STREETLY COMPUTER CLUB
86 Bankside Crescent,
Streetly,
Sutton Coldfield,
West Midlands B47 2JA.
Contact: Paul Fitzmaurice

The club meets every second Sunday of each month at the Streetly Community Centre, Foley Road East, Streetly. Paul would also be very interested to hear from anyone in his area who would be interested in forming a Sharp Users Club.

INTERNATIONAL ZX SPECTRUM CLUB
Gabriel Indalecio Cano,
Sardana, No 4 ático 2a,
San Andrés de la Barca,
Barcelona,
Spain.

The club produces a bi-monthly magazine containing software and hardware ideas, contact addresses and news. The club's objective is the interchange of programs around the world.

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Tel: 0628 21107 (evenings and weekends)
Contact: Richard Shepherd

Due to an apparent (?) lack of an active user group in the Thames Valley area (Slough, Reading, Windsor and Bracknell), Richard Shepherd is proposing to form one of his own. So, if anyone would like to swap ideas, advice, programs, etc, with other enthusiasts on a regular basis, get in touch with him as soon as possible.

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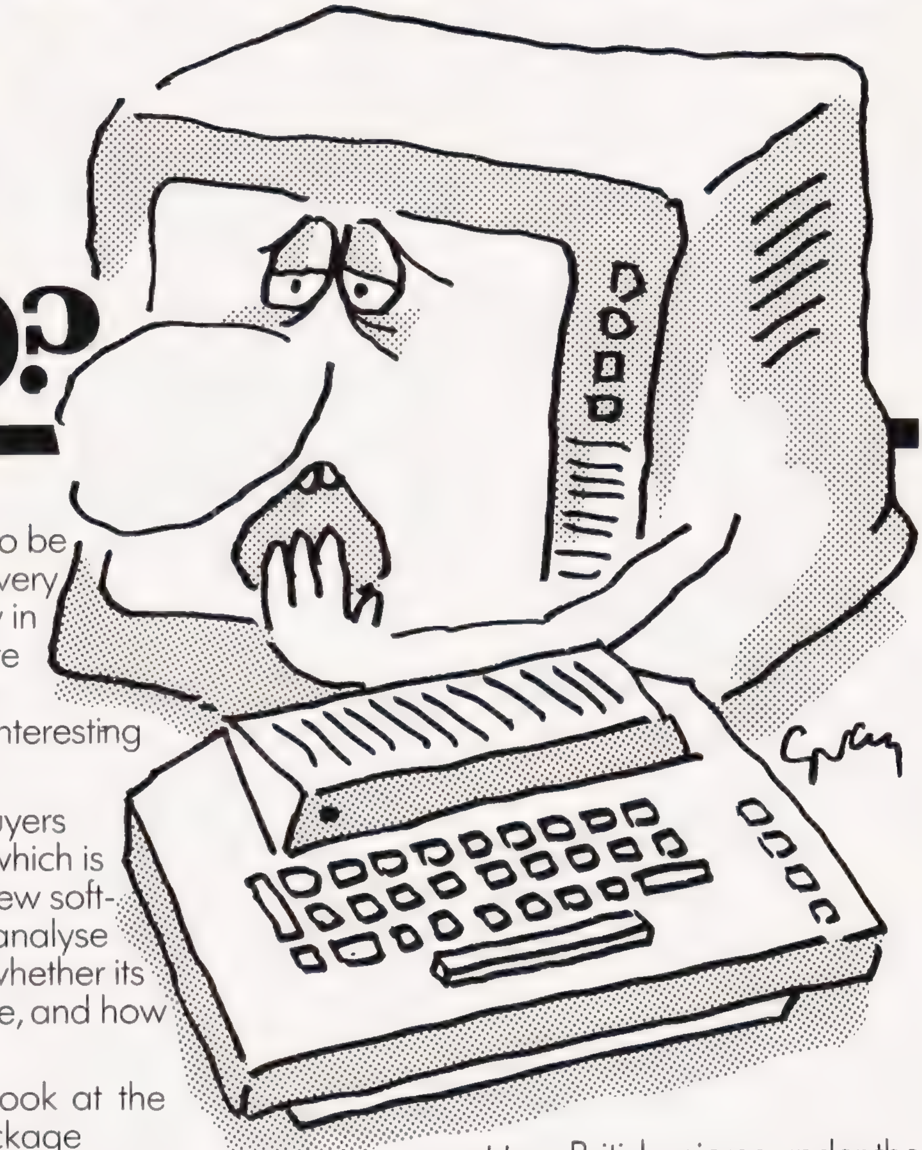

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THE A TO Z OF MICROS

Henry Budgett

CT STANDARDS

Our regular page explaining the meaning of the various symbols we use to make programs portable.

It has been very encouraging to see the number of programs submitted using our standard codes for graphics and other non-printable characters. However, it has also become increasingly clear that some of our readers haven't heard of them and this page is intended to set them out once again.

All standards tend to be irksome to adhere to but the ones laid out here are fairly simple and tend to make software easier to maintain by the programmer and simpler to understand for others.

CONTROL THAT CURSOR

Our original standards have now grown with the times. Machines such as the Commodore VIC which have a dual Shift capability can now be incorporated, as can those systems which use Control key functions.

The recently introduced BBC system offers pre-programmed function keys which, we are glad to say, can also be handled by our original coding system. It's nice to see just how well adapted the original standards have become over the last two years! (Indeed, a whole series of books is using them as its ***de-facto*** standard.) The standards for the cursor controls are given in Fig. 1.

[CLS]	CLear Screen
[HOM]	HOMe cursor
[CL]	Cursor Left
[CR]	Cursor Right
[CU]	Cursor Up
[CD]	Cursor Down
[REV]	REVerse video on
[OFF]	Turn it OFF
[SPC]	SPaCe
[CTL]	ConTroL key
[fn]	Function key (BBC)
[G<]	Graphic left (VIC/MZ-80A)
[G>]	Graphic right (VIC/MZ-80A)

Fig. 1. Our extended set of cursor control standards includes four new functions.

To indicate more than one of the above, an optional number can be placed within the brackets; [4 CL], etc.

The use of square brackets has raised one or two queries. The reason for this choice is that *most* of the common microcomputer BASICs don't use them for specific functions. In fact, at least one machine provides an added bonus by returning a Syntax Error if they are found, a useful check in case you type them in by mistake.

The code [SPC] was added to the list of cursor control codes to get over the problem of indicating just how many spaces are contained in the gap in the printout. The other common variant of the code for spaces is used by the ZX people. Their choice was '␣' and this crops up in the various newsletters they publish.

The code [RVS] has caused a few headaches. This is really specific to the PET where the character set can be displayed in reversed video. On machines which don't have this facility you should either find a character in the set which is the reversed image of the one you want and use that or simply ignore it and use anything else you fancy! Don't forget, you may have to look up and alter the values used elsewhere in the program.

THE GRAPHIC SOLUTION

It soon became obvious that the techniques applied to the confusing cursor controls could also be applied to the graphics symbols. The following standard is now in general use in programs published in *Computing Today*.

If a graphics character or characters are to be displayed in a listing (as opposed to POKE codes or CHR$( ) codes) then they are indicated by the method shown in Fig. 2.

Several people have asked what the relationship between the POKE value for a character and that of its shifted graphic might be. In general the shifted version of any character will be 64 greater than the value of that character. This applies to both PET and MZ-80K systems in all cases.

This can be taken further to include machines which use a pixel graphics set rather than pre-programmed PET-style characters and the series of codes for these is given in Fig. 3. As is nearly always the case there is one machine to which the standard shown in Fig. 3 does not apply — Tangerine's Microtan/Micron. This machine uses a four by two cell structure for its pixel graphics instead of the Prestel/Teletext three by two cell. The method for calculating the value to assign to 'P' is shown in Fig. 4, and is fortunately nice and simple.

MAKING REMARKS

Many people scorn the use of REMs within programs but, during the development at least, they are extremely useful. One of the documentation methods that we use is to keep our back-up copy of our programs on a 300 Baud CUTS tape with all the REMs in place: the working copy, be it on tape or disc, is REMless in order to save space.

It is also good programming 'manners' to give your REMs odd line numbers:

```
3999 REM ** CRASH PROOF INPUT
4000 INPUT "THE NUMBER OF ENTRIES ";A
```

A remarkable number of submitted programs have jumps that go not to the relevant point in the program, but to the REM statement. This can cause severe problems when re-numbering after removing the REMs.

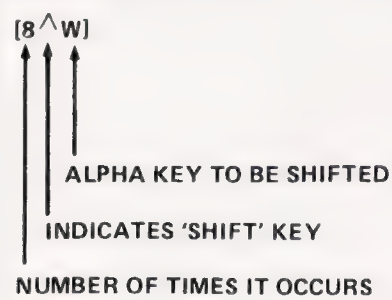

Fig. 2. The way we indicate block graphics on machines like the PET and Sharp. The VIC system of Shift Left and Shift Right is shown in Fig. 1.

1	2
4	8
16	32
64	128

Fig. 4. To convert a Tangerine pixel code into its blocks, simply decode the number into its binary or Hex value and fill in the relevant squares.

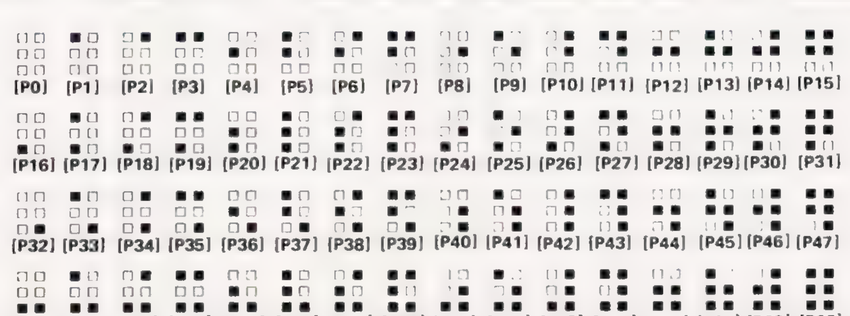

Fig. 3. The standard pixel codes; they will work on most computers which employ this technique as well as for Teletext and Prestel.

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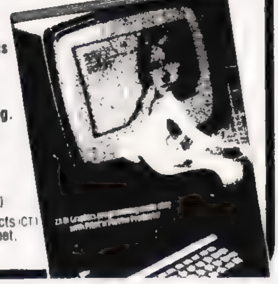

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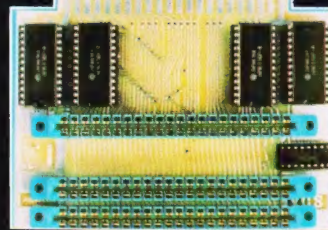

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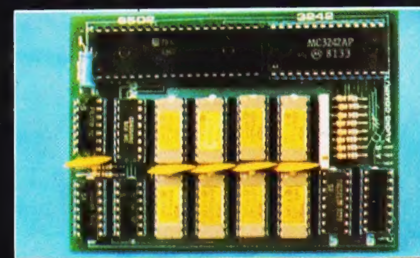

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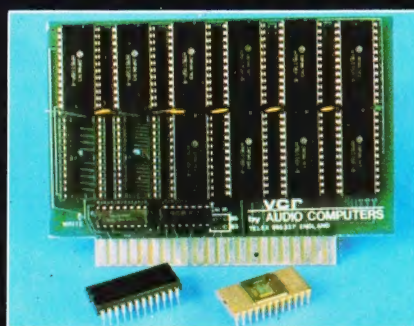

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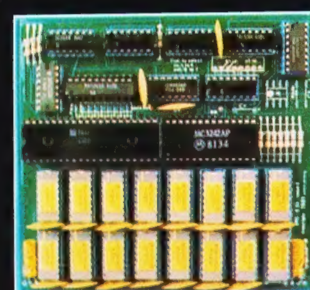

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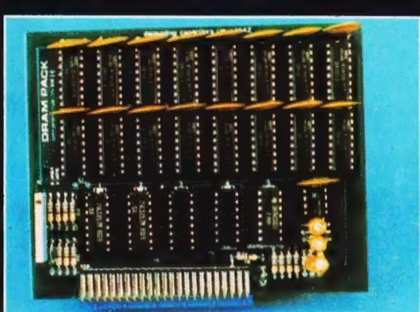

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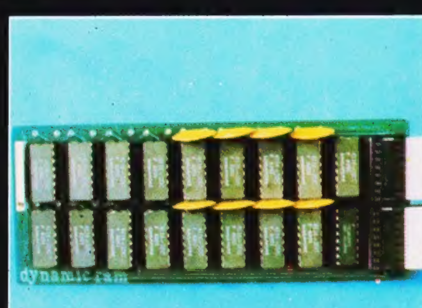

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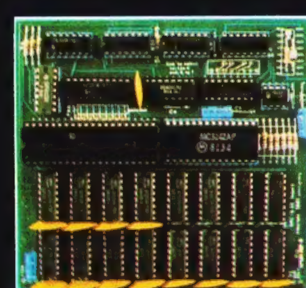

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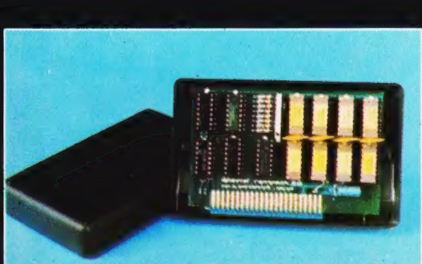

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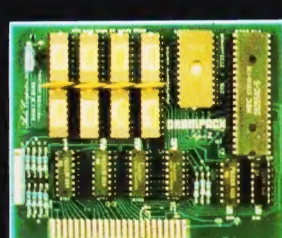

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